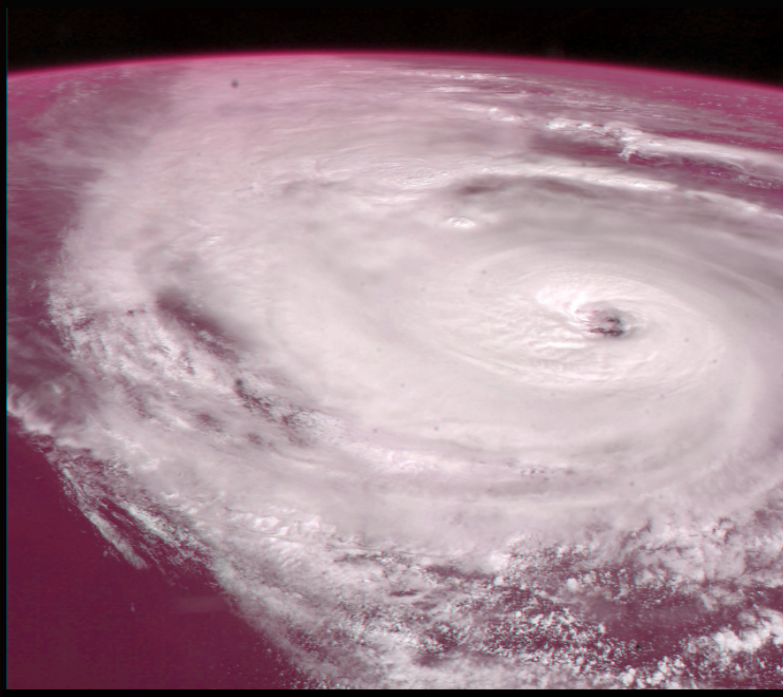




The State Climatologist

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2022



The State Climatologist

2022 Annual Summary

Volume 41, Issue 01

The State Climatologist is a publication of the
American Association of State Climatologists



Compiled by the South Carolina State Climate Office

A division of the SC Dept. of Natural Resources



Table of Contents

A Letter from the AASC President	4
About the American Association of State Climatologists	5
Corporate Sponsors	6
• Campbell Scientific	
• Synoptic Data, PBC	
2022 Regional Center Summaries	8
• National Centers for Environmental Information	
• Midwest Region	
2022 State Climate Office Annual Summaries	15
• Alabama Office of the State Climatologist	
• Alaska Climate Research Center	
• Arizona State Climate Office	
• California State Climate Office	
• Colorado Climate Center	
• Connecticut State Climate Center	
• Georgia State Climate Office	
• Hawaii State Climate Office	
• Illinois State Climate Office	
• State Climate Office of Kansas	
• Kentucky Climate Center	
• Louisiana Office of State Climatology	
• Michigan State Climatological Resources Program	
• Minnesota State Climatology Office	
• Mississippi State Climate Office	
• Missouri Climate Center	
• Nebraska State Climate Office	
• Nevada State Climate Office	
• New Hampshire State Climate Office	
• Office of the New Jersey State Climatologist	
• New Mexico State Climate Office	
• State Climate Office of North Carolina	
• North Dakota State Climate Office	
• Oklahoma Climatological Survey	
• Pennsylvania State Climate Office	
• South Carolina State Climatology Office	
• Office of the State Climatologist, Texas	
• Utah Climate Center	
• Office of the Washington State Climatologist	
• Wyoming State Climate Office	
AASC Current State Climatologists/ Office Directors	138

June 8, 2023

Welcome to the 2023 edition of *The State Climatologist*! The articles that follow summarize the developments in climate and climate services in many corners of the United States, as well as places in between.

The state climatologist program has existed in its present form for fifty years, since 1973. Prior to that, state climatologists were part of the U.S. Weather Bureau/National Weather Service. Ever since, state climatologists have continued to work closely with NOAA's National Centers for Environmental Information (formerly NCDC), the primary home of climate data within the United States. NCDC helped coordinate state climate activities and helped establish the American Association of State Climatologists in 1976.

After states assumed responsibility for state-level climate services, a wide range of approaches developed in response to local needs and resources. The richness and variety of state-level climate services is on display in this year's set of reports.

Much has changed in the past fifty years. Paper records have been scanned and digitized, while the amount of climate data has expanded so much that all the paper in the world wouldn't be sufficient to print it out. Many state climate offices have become actively involved in establishing and maintaining their own weather networks ("mesonets") for applications such as agriculture or public safety.

The American Association of State Climatologists exists to promote cooperation between State Climatologists and those federal, state, and private agencies whose functions include the collection, analysis and dissemination of climate information; facilitate exchange of information among State Climatologists; and provide mutual assistance in the development of effective State Climatologist programs. This edition of *The State Climatologist* serves all three functions. I hope you will find in these pages inspiration and ideas for products and services you can either utilize or provide.



John W. Nielsen-Gammon
Regents Professor and Texas State Climatologist
President, American Association of State Climatologists

About the American Association of State Climatologists

The American Association of State Climatologists (AASC) is a professional scientific organization composed of state climatologists (one per state), directors of the six Regional Climate Centers and associate members who are persons interested in the goals and activities of the Association. State Climatologists are individuals who have been identified by a state entity as the state's climatologist and who are also recognized by the Director of the National Centers for Environmental Information of the National Oceanic and Atmospheric Administration as the state climatologist of a particular state. Upon receipt of the materials and approval of the AASC Executive Board, a Memorandum of Agreement (MOA) with the National Centers for Environmental Information (NCEI) shall be issued. Currently, 38 states have received ARSCO status.

State Climatologists currently exist in 48 states and Puerto Rico. They are typically either employees of state agencies or are staff members of state-supported universities. Associate members may be assistant state climatologists or other climatologists under the employment of the state climatologist, representatives of federal climate agencies, retired state climatologists, or others interested in climate services. For more info, see <https://stateclimate.org>

ARSCO

A state climate office may gain status as the AASC-Recognized State Climate Office (ARSCO) by providing:

1. A document detailing current and planned activities meeting ARSCO requirements;
2. A letter of support from the state's Regional Climate Center Director;
3. A letter of support from at least one National Weather Service Forecast Office serving the state.

Candidate offices must demonstrate the following capabilities:

- Communication capabilities – the office must be able to communicate with its clientele via multiple media, including telephone, Internet, mail, E-mail, and fax;
- Information services – the office must be capable of providing a range of data and information;
- Research – the office must conduct research on climate and human activities;
- Outreach – the office should design products and services for education, climate information, awareness, and the media;
- Monitoring and assessments – monitoring climate conditions, evaluating future impacts, and providing historical context to events are activities conducted by ARSCOs.



Mesonet Data Confidence

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- Meteorological Sensors
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From single research weather stations to mesoscale weather networks (mesonets), Campbell Scientific automatic weather stations have become the global standard for climate and boundary-layer meteorology. They are integral parts of forecasting and monitoring systems worldwide. Accurate measurements, low power requirements, and proven reliability in extreme weather conditions make our weather stations ideal for all types of meteorological and climatological monitoring anywhere on Earth.



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A PBC is focused on People, the Planet, and Sustainability.

Synoptic is on a mission to expand access to weather and environmental data for all.

Synoptic Data is the industry leader in aggregating, processing, and disseminating real-time and historical measured weather and environmental observations for users in a variety of sectors and applications.

As a Public Benefit Corporation (PBC), Synoptic is committed to providing expanded access to environmental data to enhance public safety, improve the productivity of government agencies and commercial entities, and assist in research and educational initiatives to advance the understanding of Earth systems.

NATIONAL
MESONET

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2022 National & Regional Centers

NOAA's National Centers for Environmental Information

Annual Report for 2022

National Partnership Liaison: Tamara Houston

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Website:

<https://www.ncei.noaa.gov/>

Social media

Facebook: <https://www.facebook.com/NOAANCEI>

Twitter: <https://twitter.com/NOAANCEI>

Instagram: <https://www.instagram.com/noaadata/>

Email:

ncei.orders@noaa.gov

Tamara.Houston@noaa.gov



NATIONAL CENTERS FOR
ENVIRONMENTAL INFORMATION

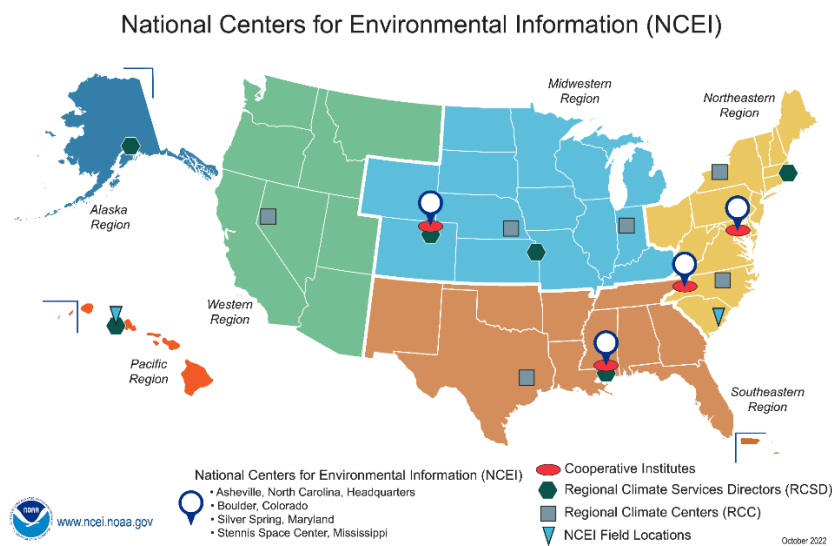
About NOAA's National Centers for Environmental Information (NCEI)

NCEI hosts and provides access to one of the most significant archives on earth, with comprehensive oceanic, atmospheric, and geophysical data. From the depths of the ocean to the surface of the sun and from million-year-old ice core records to near-real-time satellite images, NCEI is the Nation's leading authority for environmental information.

By preserving, stewarding, and maximizing the utility of the Federal government’s billion-dollar investment in high-quality environmental data, NCEI remains committed to providing products and services to private industry and businesses, local to international governments, academia, as well as the general public.

The demand for high-value environmental data and information has dramatically increased in recent years. NCEI is designed to improve NOAA’s ability to meet that demand. The Consolidated and Further Continuing Appropriations Act, 2015, Public Law 113-235, approved the consolidation of NOAA’s existing three National Data Centers: the National Climatic Data Center, the National Geophysical Data Center, and the National Oceanographic Data Center into the National Centers for Environmental Information.

NCEI headquarters are located in Asheville, NC with other major locations in Boulder, CO, Silver Spring, MD, and Stennis Space Center, MS.



202 Highlights

[Assessing the U.S. Climate in 2022](#)

Drought sets records across the contiguous U.S. in 2022

The [average annual temperature of the contiguous U.S.](#) was 53.4°F, which is 1.4°F above average, ranking in the warmest third of the record.

[Annual precipitation](#) for the contiguous U.S. was 28.35 inches, 1.59 inches below average, ranking in the driest third of the historical record.

There were 18 separate [billion-dollar weather and climate disaster](#) events identified during 2022 — the third-highest disaster count and the third-costliest year in the 43-year record.

Drought coverage across the contiguous U.S. remained significant for the second year in a row with a minimum extent of 44% occurring on September 6 and a maximum coverage of 63% on October 25 — the largest contiguous U.S. footprint since the drought of 2012.

[*New nClimGrid Products for the Contiguous U.S.*](#)

nClimGrid-Daily and Daily Gridded Normals Now Available

NCEI's new [nClimGrid-Daily](#) product contains 5-km gridded fields with area averages of daily temperature and precipitation amounts for the contiguous United States—with data from January 1, 1951, to the present. In addition to the daily gridded data, NCEI is now producing climate normals of key variables, based on the same underlying 5-km grid.

These all-new datasets will help place regional- to national-scale meteorological events into a long-term historical context in near-real-time. Additionally, these NOAA gridded datasets can be certified for official use.

Gridded datasets include several variables that can be used to understand the weather conditions on any given day.

[*Billion-Dollar Disasters: Mapping Vulnerabilities with Census Tract-Level Data*](#)

The NCEI [Billion-Dollar Disaster and Risk Mapping tools](#) now include U.S. Census tract data, expanding on [FEMA's National Risk Index](#) to provide an integrated view of U.S. hazard risk, exposure, and vulnerability across more than 100 combinations of weather and climate hazards.

These enhanced interactive maps provide data for over 72,000 U.S. Census tracts, which are small subdivisions of counties that average about 4,000 inhabitants. Users can now visualize combined physical exposure, socioeconomic vulnerability, and markers of resilience to natural hazards on a finer scale than ever before.

[*Gridded Climate and ENSO Normals Products Released*](#)

New gridded products allow easier use and visualization of climate data

Temperature and precipitation averages and statistics are calculated every decade so we can put today's weather into proper context and make better climate-related decisions. These 30-year averages, called "climate normals," can be described as a benchmark of climate conditions across the United States. Normals are vital to many scientific, engineering, and economic interests. For example, a construction firm bidding on a job starting in four months can use normals to know how many rainy days to build into a schedule. Electric utilities can use heating and cooling degree day normals in planning base load factors, and temperature threshold exceedance frequencies for peak load assessment. An individual traveling for leisure can get an idea for a good time of year to visit a place, although in this and the other cases the actual weather can surprise them.

On the heels of last year's [decadal update to the 30-year climate normals](#), our scientists have released a new type of normals product: Monthly Gridded Climate Normals, which increase options for visualizing and studying climate data and make research easier for many users. Also, another product is being released for the first time: [ENSO Gridded Climate Normals](#).

[NOAA Addresses Climate in Each State](#)

Local perspective emphasized in individual U.S. state summaries

New climate summaries from NOAA offer up-to-date, local perspectives on climate in each state, covering the entire United States plus Puerto Rico and the U.S. Virgin Islands. The new State Climate Summaries have been developed in partnership with the [Cooperative Institute for Satellite Earth System Studies](#) (CISESS), six [Regional Climate Centers](#) (RCCs), and individual [state climatologists](#). [An interactive website](#) hosted by CISESS gives the public easy access to the information.

The State Climate Summaries spell out recent local conditions for each state and provide insights about the state's climate outlook based on historical trends. Climate is distinguished from daily weather because climate reflects a longer period of time and measures averages of weather conditions. The summaries, which are available both as web pages and downloadable PDFs ranging from four to six pages in length, describe historical temperature and precipitation conditions for each state and use several visual aids to show past observations and plausible future projections.

To read more NCEI news stories, click [here](#).

Midwest Region

Midwestern Regional Climate Center

Annual Report for 2022

Director: *Beth Hall, PhD*

Associate Director: *Melissa Widhalm*

Service and Outreach Climatologist: *Austin Pearson*



MRCC

Midwestern Regional
Climate Center

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@MidwestClimate

About the MRCC

The MRCC, which relocated to Purdue University in 2021, has been fulfilling the climate services needs of its 9-state region (MN, WI, IA, MO, IL, MI, IN, OH, KY) since 1982. The center is a partner of the National Centers of Environmental Information (NCEI) Regional Climate Services program that includes five other regional climate centers and the state climate offices. Its services and research help to explain climate and its impacts on the Midwest, provide practical solutions to specific climate problems, and enable the development of useful and usable climate information and resources for the Midwest on climate-sensitive issues such as agriculture, climate change, energy, the environment, human health, risk management, transportation, and water resources.

Administration and Staffing

The MRCC operates under the leadership of MRCC Director Dr. Beth Hall with support from numerous permanent staff including Melissa Widhalm (Associate Director and Regional Climatologist), Jonathan Weaver (Senior Research Analyst and Applications Manager), Austin Pearson (Service and Outreach Climatologist), Mat Hollinger (Climate Data Programmer), Danny Brouillette (Climate Data Programmer), and Kat Slover (Climatologist). Next year, an additional climatologist and data programmer will likely be added to the staff.

Systems Modernization

In late 2021, the MRCC launched a large-scale project to modernize all MRCC systems. This includes a complete back-end overhaul of the computational infrastructure with respect to software, data storage, website design, and linkages with MRCC servers. Modernizing the computational framework will allow the MRCC to have a system designed with a software engineering perspective, allowing for easier growth, enhancements, modularity, and transportability. This work was ongoing through 2022 and is expected to be complete in 2023.

Climate Services, Products, and Applications

Throughout 2022, representatives from numerous sectors (*i.e.*, legal, consultants, and engineers) contacted the MRCC service office seeking climate data and services, with over 230 specialized requests submitted. Website analytics reveals the MRCC logged over 1.2 million pageviews from over 145,000 unique users. MRCC data, products, and personnel were referenced in over 150 articles in the popular press. The MRCC's quarterly e-newsletter, *The Climate Observer*, expanded subscribership to about 700 people with an average 64.8% open rate and an 18.8% click rate. This far exceeds the education industry benchmark of a 15.7% average open rate and 2.9% average click rate.

The MRCC released two new products in 2022. The **Freeze Date Tool** is an interactive resource that lets users explore climatologies of and trends in local first/last freeze dates and growing season length. It provides seamless movement between regional scale maps and local scale charts while giving users various customized data options. The **Snowfall Climatology Toolbox** provides streamlined access to high-quality station-level snowfall data across the continental US.

There were also improvements made to numerous existing tools and products during 2022. Selected updates are noted below.

- Five additional years of data were added to the **Tornado Tracks Tool**. Users can now explore tornadoes from 1950-2022.
- The **Corn GDD Tool** now includes climate normals from 1991-2020.
- Users can download daily **Accumulated Winter Season Severity Index (AWSSI)** data from all past seasons.
- Access was restored to the **Keetch-Byram Drought Index (KBDI)** maps, the **ET and Water Balance** maps, and the **VIP Chilling Hours** maps.
- Additional holidays and occasions were added to cli-MATE's **This Day in History**.
- Users can now view **Inverse Wind Roses** in the cli-MATE self-service data portal.

Anticipated new releases from the MRCC in 2023 include:

- Completely new public website
- Interactive accumulated chilling hours tool
- Soil temperature climatology for the north central US
- Expansion of stations included in the Regional Mesonet Program (RMP) maps
- Additional legacy products updated with 1991-2020 normals

Collaboration Efforts, Outreach, and Engagement

The MRCC collaborates with numerous partners across the Midwest to identify climate data and service needs, develop and enhance climate products, and improve regional communication and coordination. Key collaborators include the National Integrated Drought Information System (NIDIS), USDA Midwest Climate Hub (MWCH), National Weather Service, NOAA Great Lakes Region Collaboration Team, NOAA Central Region Collaboration Team, and the Midwest Mesonet Consortium.

In January 2022, the MRCC hosted the Midwest Climate Partners Directors meeting. This virtual event convened leadership from the USDA Midwest Climate Hub, USGS Midwest Climate Adaptation Center, the Great Lakes RISA, the Central Regional National Weather Service, the

Great Lakes NOAA Regional Coordination Team, the National Integrated Drought Information System, the National Drought Mitigation Center, the Northern Institute of Applied Climate Science, the Midwestern Regional Climate Center, and the Central Region's Regional Climate Services Director. The goals of this meeting were to 1) discuss individual program priorities, 2) discuss plans to better leverage each other's work so we can complement, support, and raise awareness to others, and 3) to identify collaborative opportunities.

In May 2022, the MRCC hosted a one-day virtual meeting with all State Climate Office staff across the 9-state region. During this meeting, attendees discussed new and ongoing climate services work, needs, and challenges in the region. The MRCC shared updates on improvements and priorities. The overall intent of this meeting was to assess information needs in the region and strengthen climate services collaborations in the Midwest.

In August 2022, the MRCC hosted a three-day workshop on regional climate services in partnership with the NOAA Great Lakes Regional Collaboration Team. This workshop was designed specifically for National Weather Service (NWS) Climate Focal Points and other NWS personnel working on climate issues at offices in the Great Lakes region. Thirty-four attendees learned about regional climate services, gained hands-on experience with online tools, interacted with state climatologists and other climate services partners, and networked with neighboring offices.

MRCC staff participated in a variety of national, regional, and local meetings and events throughout the year to share climate data expertise, gather stakeholder input, and keep informed of emerging and ongoing climate issues in the Midwest.

Anticipated engagement activities from the MRCC in 2023 include:

- Continued publication of the MRCC quarterly newsletter, *The Climate Observer*
- Host an in-person workshop with state climate offices across the Midwest to share and exchange updates and information needs
- Begin "regional road trips" to meet with existing and new partners across the Midwest

State Climate Office Annual Summaries

Alabama Office of the State Climatologist

ARSCO Annual Report for CY2022

State Climatologist: John R. Christy

Associate State Climatologist for Agriculture: W. Lee Ellenburg

Assistant State Climatologist: Lawrence Carey, Robert Junod

Staff/Service Climatologists: Jennifer Geary, Whitney Guerin, Abigale Barre, Liz Junod

Affiliation/sponsor: University of Alabama in Huntsville

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Social media:

Email addresses

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About the Alabama State Climate Office

It is the role of the Office of the State Climatologist to provide weather and climate information to the public and to private interests to improve decision making activities that affect both the environmental quality and the economic vitality of the State. Activities include providing specific historical weather data for the State and for the world, developing plans to mitigate the economic impacts of weather and climate variability and providing consultation on the use, interpretation and availability of weather and climate information. The Alabama Office of the State Climatologist also directly engages in important societal debates such as global warming through basic research, hosting workshops, providing congressional testimony and participating in educational activities.

Communication Capabilities

The main communication method is through publications we produce as they are accessed through the internet. Our website is: <https://www.nsstc.uah.edu/aosc/>

Dr. Rob Junod produces and writes our monthly state information reports and stories related to unusual events, particularly those of the past 150 years. A part-time communications expert and former on-air TV meteorologist has helped us to participate occasionally in social media outlets through the Earth System Science Center's website in which some of the State Climatologist's Office is featured <https://www.uah.edu/essc/essc-news>. However, due to the type of information we provide, the type of customers who utilize our products, and the resources available to provide it, we generally do not use social media. We have found that straightforward weather and climate products are freely available on many well-maintained platforms such as the Southeast Regional Climate Center or NOAA's Climate-at-a-Glance websites that our time and resources are best spent on the type of projects which provide direct support.

Information Services, Products and Tools

The State Climatologist produces unique, daily products related to water resources and agriculture.

Lawn and Garden Index: https://www.nsstc.uah.edu/aosc/lawn_garden_se.html

We produce several high-resolution, daily antecedent products (average insolation, total precipitation, maximum temperature, minimum temperature) that are utilized to generate the agricultural stress products through the system we call GRIDSSAT.

[This Product is being upgraded and is offline]

Each month we generate the Alabama Climate Report which is a summary of the state's climate of the past month with historical information about the coming month if remarkable.

<http://nsstc.uah.edu/alclimatereport/>

Each month our research team generates global grids of satellite-based temperatures for climate monitoring. This is an important product as it is utilized for assessments of climate variability and change at the highest levels.

<http://nsstc.uah.edu/climate/>

The office is regularly called upon by the state development office to write climate summaries for industrial recruitment in specific cities and/or counties. The main issues that concern potential

industry are tornadoes, hurricanes and floods. We provide detailed, probabilistic results regarding the chance of such events impacting the potential location.

Research, Projects and Publications

The Alabama Climate Report is a monthly summary of the state's climate with historical information about the coming month. In addition, as part of a major research center with over \$18M in annual expenditures (Earth System Science Center whose Director is the State Climatologist), research is obviously a priority.

The State Climatologist, with colleagues, publishes research papers that address local, regional and global climate. For example, the following 2022 papers address several critical aspects of the global climate, including long-term monitoring for climate change analysis, ancient historical climate in Greece, and snowfall in the American West.

McKittrick, R. and J.R. Christy, **2020**: Pervasive warming bias in CMIP6 tropospheric layers. *Earth and Space Science*, 7, American Geophys. Un., doi.org/10.1029/2020EA001281.

Though this is the ARSCO report for 2022, we were informed early in 2022 that the above paper was honored as one of the "Top Ten Downloads" from the AGU journal Earth and Space Science in 2021.

Christy, J.R., **2022**: Time series construction of Oregon and Washington snowfall since 1890 and an update of California snowfall through 2020. *J. Hydromet.* DOI:10.1175/JHM-D-21-0178.1.

The above paper was selected as a highlighted entry in the AMS "News you can use" and was also selected to be highlighted in BAMS in the section "Papers of Note" indicating its popularity and importance for climate variability and change in the West.

Po-Chedley, S., J.R. Christy, L. Haimberger and C. Mears: **2022**: Tropospheric Temperature [Global climate; Temperature; Lower Tropospheric Temperature [in "State of the Climate in 2020"], *Bull. Amer. Meteor. Soc. Bull. Amer. Meteor. Soc.*, **103** (8), S36–S39, <https://doi.org/10.1175/BAMS-D-22-0092.1>.

Sargentis, G.-F., D. Koutsoyiannis, A. Angelakis, J.R. Christy, and A.A. Tsonis, **2022**: Environmental determinism vs. social dynamics: Prehistorical and historical perspectives. *World*, 3, 357-388, doi.org/10.3390/world3020020.

Kim, D. and J.R. Christy: **2022**: Detecting impacts of surface development near weather stations since 1895 in the San Joaquin Valley of California. *J. Theor. App. Climatology*, DOI: 10.1007/s00704-022-04107-3.

Global climate research is particularly important as federal regulations which attempt to deal with "global warming" have a particularly negative impact on the economy of Alabama and its many poor people with demonstrably no impact on the climate itself (see congressional testimony). The

State Climatologist is also a contributing author of the global tropospheric temperature section produced for the *Bulletin of the American Meteorological Society's* annual State of the Climate report (see above) after serving as Lead Author for several years.

In 2021 the State Climatologist produced a report, free for downloading, "A Practical Guide to Climate Change in Alabama". This report answers many questions asked by residents, government and industry in Alabama and in 2022 continues to be a popular download from our website. The report has been utilized by numerous legal and corporate entities as it presents the information in a way the qualifies as "Admissible Evidence" in litigation and stands up to cross-examination.

https://www.nsstc.uah.edu/aosc/climatechangePDF/AlabamaClimatePracticalGuide_hires.pdf

The office is still performing on a NOAA 2020 grant (and subsequent plus-ups) to the State Climatologist to enhance, modernize and improve soil moisture efforts in the state. We have and will continue to install both research-grade and low-cost instrumentation (which UAH designs and builds) across the state and combined with our daily agricultural models (which produce stress indices, soil moisture estimates) and satellite assimilation will provide a homogeneous representation of soil moisture and plant-stress categories. This will also fold in the 10-day forecast to depict potential flash-droughts which have been a significant problem for the SE.

Outreach and Education (in addition to on-going activities listed in previous reports)

The State Climatologist has testified before 20 congressional committees on climate variability and change and has advised several members of congress and industrial executives in private discussions.

In CY22 we made significant progress on the federal initiative to bring irrigation to farms in Alabama with the current assessment indicating a tripling of irrigated acreage since our initiative began. Working with our congressional delegation since 2010, we were able to secure multi-year federal funding for states (primarily in the SE) for irrigation infrastructure. The critical role of the SC at present is to produce the watershed management plans for USDA approval so farmers may be funded. This requires on-site examination of individual farms and talk with the growers about specific issues. Two watersheds have now been completed and two more are in review. The budgetary impact on Alabama for the irrigation infrastructure alone will be above \$100M which then generates downstream economic development of at least twice that amount.

The State Climatologists speaks at numerous venues each year including universities, civic organizations, schools, private industry meetings, litigation teams, state government panels, etc.

Due to our increasing role in agriculture, we hired W. Lee Ellenburg, PhD, in 2021 to lead in this effort and to manage the new NOAA soil moisture project. In 2022 he has done an outstanding job in connection with agencies and organizations around the state.

Monitoring and Impact Assessment

The State Climatologist is a member of the Monitoring and Assessment Group hosted by the Alabama Office of Water Resources. This group monitors water resources and meets regularly to assess drought designations for the state's regions.

The State Climatologist is a member of the Governor-appointed Alabama Water Agency Working Group which is examining the potential for a statewide water management plan.

The State Climatologist owns and operates a 16-station climate network with instrumentation identical to the NOAA Climate Reference Network (CRN) with satellite-reporting every hour with observations displayed on the NOAA CRN website. We are also working with Baron Critical Weather Institute to establish hundreds of UAH-designed and built, low-cost stations across the state for very-high-resolution (spatial and temporal) sampling of the weather and climate.

The State Climatologist is the lead for making recommendations to the Drought Monitor each week and is thus in constant contact with water users and water organizations around the state.

Alaska Climate Research Center - Alaska State Climate Center (ACRC - ASCC)

ARSCO Annual Report for 2022



State Climatologist:

Martin Stuefer, Director ACRC, Research Professor

Assistant State Climatologist:

Julia Simonson – Post-Doctoral Fellow until July 2022

Lea Hartl - Post-Doctoral Fellow, Successor of J. Simonson, July 2022 - current

Staff/Service Climatologists:

Lea Hartl –ACRC Post-Doctoral Fellow

Carl Schmitt - Assistant Professor

Curtis Bernard – Research Technician

Telayna Wong – Research Technician

Ross Burgener – Research Technician

Blake Moore – Research Technician

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About the Alaska State Climate Office

The Alaska Climate Research Center (ACRC) is part of the Geophysical Institute, University of Alaska Fairbanks (UAF). The ACRC has merged with the Alaska State Climate Center (ASCC) in 2018. The main tasks and objectives of the ASCC have been renewed within the 2022 Alaska State Statutes via Title 14, Chapter 40, Section 085. Specific information can be found about this statute at <https://law.justia.com/codes/alaska/2022/title-14/chapter-40/article-1/section-14-40-085/>. Funding support for the ACRC comes from the Geophysical Institute, the State of Alaska, and externally funded research projects.

Main ACRC objectives are summarized as the following:

- Dissemination of climatological information and data.
- Engage and improve weather and climate observations within the State of Alaska.
- Research on climate variability and climate change in Alaska and Polar Regions, and
- Education and engagement with our stakeholders.

Communication Capabilities

For three decades, we have made climatological data available to the public, private, and government agencies, and to researchers around the world. Public inquiries about weather, climate and air quality related topics are received throughout the year. Most communication is entertained by email, telephone and social media.

The Alaska Climate Research Center offers a variety of website services, and communicates and disseminates climate information using the following:

<https://akclimate.org/> - the ACRC main webpage has been renewed and updated for easier use. Climate and project information as well as data services including a variety of data download options have been provided within the new web service.

<https://www.cocorahs.org/state.aspx?state=ak> - new emphasis has been placed to further CoCoRaHS in Alaska. We have increased the number of active observers in 2021.

<https://meso1.chpc.utah.edu/usarray/> - Alaska has become a Mesonet State by ‘adopting’ the NSF US-Array station network through the University of Alaska system. We successfully received NSF funding to develop a sustainable network.

In addition, climate reports and CoCoRaHS newspapers have been disseminated throughout the year 2022.

Information Services, Products and Tools

The ACRC disseminates climate summaries, data products, meteorological and climatological information. We inform about Alaska weather and climate, maintain weather, radiation and temperature profiler instruments at various locations; we also have popular webcams, and an on-campus weather station. The ACRC services and also our webpage provides climatological data, up-to-date summaries, information for tourists, seasonal and other weather and climate links, and a spotlight on climate of Alaska. Main information services relate to wildfires during the summer season. Our ‘UAFSmoke’ webpage (<http://smoke.alaska.edu/>) informs about current wildfire activity in Alaska, and shows predictions of wildfire smoke dispersion for a forecast period up to 72 hours. We run our own WRF-Chem model forecasts with a synthesis of up-to date wildfire information daily.

The ACRC staff responds to specific requests for data, which are normally received online, by telephone, and sometimes by walk-ins (no walk-ins in 2021 due to the pandemic situation). The service is normally free of charge.

We publish monthly and annual reviews both for selected cities (Utqiagvik, Fairbanks, Anchorage, Nome, King Salmon, Juneau, Ketchikan, Bethel, Bettles, Delta Junction, Cold Bay, Gulkana,

Homer, Kodiak, Kotzebue, McGrath, St. Paul Island, Talkeetna, Yakutat) as well as for Alaska as the State.

The ACRC facilities include a 100-foot tall meteorological tower to monitor weather and climate in the Fairbanks area. The tower has temperature and ultrasonic wind sensors at several elevations, a solar radiation sensor and other meteorological monitoring equipment. The tower is also equipped with a temperature profiler and PM2.5 sensors to continuously monitor air quality and winter inversions. Other facilities include radiation instruments and a test facility for new radiation sensor developments.

ACRC monitors weather and climate, and supports maintenance (in cooperation with the Alaska Earthquake Center) of 68 Mesonet sites across the state.

Research, Projects, and Publications

- Work focus was directed towards the following externally funded and continuing research projects:
 - UAF DOE ARM (Atmospheric Radiation Measurement) Rapid Response: Our ARM team supports maintenance, development, and troubleshoot efforts of the Alaska ARM observatory of Utqiagvik, Alaska, where a multitude of meteorological instruments, radars, profilers and other modern instruments collect data continuously. The ARM Rapid Response team ensures data quality, helps troubleshoot IT and instrument issues at the sites, and supports field projects.
 - DOE ARM Instrument Mentorship: We are the DOE ARM mentors for Cryogenic Frost Point Hygrometer (CFH) measurements in support of the WMO GCOS Reference Upper-Air Network (GRUAN, <https://www.gruan.org/>), the MASC (Multi-Angle Snow Camera), the PIP (Precipitation Imaging Package), and multiple ARM camera systems.
 - US-Array: Funded by NSF, we have been elected to maintain and further develop the Alaska Transportable Array (TA). The TA is a network of 400 high-quality broadband seismographs and [atmospheric sensors](#) that have been operated at temporary sites across the conterminous United States from west to east in a regular grid pattern. The TA finished its eastward migration in fall 2013, and has been [deployed in Alaska](#) about 6 years ago. Our US-Array project aims to maintain selected Alaska TA sites with seismic and meteorological sensors, to advertise the use of the data, find new applications and investors, and create a sustainable network. The Alaska TA network fills a vast data sparse region.
 - Alaska Mesonet: Since September 2020, Alaska officially became a partner of Mesonet. The ACRC in collaboration with the Alaska Earthquake Center provides high-quality data to the National Mesonet Program. The ACRC through the US-Array so far provides meteorological data from 68 US-Array stations to Mesonet.
 - NASA Hazards: The ACRC in collaboration with the Geographic Information Network of Alaska, provides critical satellite remote sensing data to detect and track volcanic ash and SO₂ plumes. ACRC staff also developed new WRF-Chem applications to simulate extreme aerosol cases such as wildfire emissions and volcanic plumes.
 - NASA Haqast: **Air quality and health impacts of boreal fires: decision support and applied research supported by NASA satellite products.** We are working with MODIS and VIIRS fire products and aerosol products together with air quality real-time prediction

- outputs from 3 different models and surface observations to enrich the application of NASA's satellite data for air quality management and decision making in Alaska.
- CoCoRaHS: Martin Stuefer, is the Alaska state coordinator for CoCoRaHS. New initiatives and efforts have started to advertise CoCoRaHS in the state, and increase the number of observers.
 - UAFSmoke: Near-real time prediction of emissions from Alaska wildfires has been provided during the Alaska wildfire season. The 'UAFSmoke' forecasts have been maintained in support of the BLM Fire Service, the public and also the larger aviation community.
 - EPSCoR Fire & Ice: ACRC staff is in charge of the UAF Hyperspectral Laboratory (HyLab, <http://hyperspectral.alaska.edu>), and provides airborne hyperspectral data, data processing and analysis for the Fire & Ice project. We have provided airborne services including acquisition of hyperspectral and particle spectrometer data.
 - Secure and Resilient Power Generation in Cold Region Environments: As part of ACRC's environmental impact studies, ACRC has been engaged in research funded by the US-Army to assess the impact of existing and new energy resources. Various power plants emit particles as well as water vapor to the environment. During the Arctic winter, water vapor emissions produce dense ice fog and visibility problems in populated areas. Ice fog microphysical observations as well as ice fog dispersion modeling studies using new numerical model simulations have been conducted.

Publications and presentation abstracts 2022

- NA Krotkov, VJ Realmuto, C Li, CJ Seftor, JY Li, KW Brentzel, M Stuefer, ..., 2022: [Enhancing Direct Readout Capabilities for Day-Night Monitoring of Volcanic SO₂ and Ash for Aviation Avoidance at Northern Polar Latitudes](#), AGU Fall Meeting Abstracts 2022, IN45D-0390
- JS Delamere, J Cable, C Dierking, O Larson, J Mao, M Stuefer, AS York, 2022: [The JPSS Program: Providing Critical Services to Alaska Wildfire Operations](#), AGU Fall Meeting Abstracts 2022, IN45C-0386
- CF Waigl, H Greaves, J Schmidt, M Stuefer, A Britz, SK Panda, M Berman, 2022: [The 2019 McKinley Fire in South-Central Alaska: burn severity and fire effects from high-resolution aerial imaging spectroscopy](#), AGU Fall Meeting Abstracts 2022, B55C-05
- JB Halverson, B Rippey, R Thoman, M Stuefer, B Moore, J Grimes, L Hartl, 2022: [Weatherwatch](#), Weatherwise 75 (4), 42-57
- B Rippey, R Thoman, M Stuefer, B Moore, J Grimes, L Hartl, JB Halverson, 2022: [Weatherwatch: November 2021](#), Weatherwise 75 (2), 32-48
- J Delamere, C Dierking, J Cable, G Wirth, C Smith, M Stuefer, WH Barndt, 2022: [20 Years Supporting the Real-Time Observational Needs of Alaskans](#), 102nd American Meteorological Society Annual Meeting

Outreach and Education

We have been giving talks and seminars on the climate and observed climate change in Alaska and the Polar Regions in general. ACRC staff provided educators and community groups with charts and data for use in educating their classes and communities. WE answered a variety of

queries from the community regarding issues such as for example Alaska's warming, and abnormal weather events in Alaska, ice fog or smoke specifics.

ACRC participated as a main exhibitor at the UAF Open House event in May 2022. Creating weather and climate awareness and sparking interest to become for example a CoCoRaHS observer are main objectives of our outreach efforts.

Monitoring and Impact Assessment

Monitoring, and observational support at our own facilities, the DOE ARM sites of Alaska, as well as maintaining Alaska Transportable Array sites and the Alaska Mesonet have been an ACRC focus (see descriptions and projects above).

The impact of our ACRC work can be best demonstrated based upon our work to assess and predict wildfire emissions (<http://smoke.alaska.edu/>). We had over 1,000,000 visitors of our 'UAFSmoke' webpage already in early June due to an extreme fire season. 2022 was among the years with most area burned in Alaska. More than 3 million acres burned across Alaska in summer 2022. The 3 million mark was only reached in 7 years (2022, 2015, 2005, 2004, 1990, 1969, 1957) since accurate reporting began in 1950. The 2022 season started earlier than in most years and reached 1 million burned acres by June 19th. The increase in burned acreage was especially steep between the end of June and mid-July due to a combination of intense lightning activity and dry conditions on the ground. The increase in acreage and in the total number of fires then dropped off sharply as weather patterns shifted. Fuels were dampened by widespread precipitation and lightning frequency decreased (<https://akclimate.org/2022-fire-season-winding-down/>).

Arizona State Climate Office

ARSCO Annual Report for 2022

State Climatologist: Erinanne Saffell, Ph.D.

Assistant State Climatologist: None

Staff/Service Climatologists: Assistant Climatologist: Juliana Likourinou Student Worker: Payton Major

Volunteers: Twenty-one undergraduate students and community members

Affiliation/sponsor: Arizona State University

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Mailing Address: Arizona State Climate Office
Arizona State University PO
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Tempe, AZ 85287-5302

Telephone number: 602-543-3636

Fax number: none

Website(s): <https://azclimate.asu.edu>

Social media: Twitter: @AZStateClimate
Facebook: @AZStateClimate

Email address(es) (individual and/or organizational):

State Climatologist: Erinanne.Saffell@asu.edu Assistant
Climatologist: Juliana.Likourinou@asu.edu Office:
AZclimate@asu.edu



About the Arizona State Climate Office

The Arizona State Climate Office (Office) is housed within the School of Geographical Sciences and Urban Planning (SGSUP) and affiliated with the Julie Ann Wrigley Global Futures Laboratory (GFL) and the Urban Climate Research Center (UCRC) at Arizona State University (ASU) in Tempe, AZ. The Office became a Weather-Ready Nation Ambassador (NOAA) in 2021.

The Office was relocated to the Arizona State University Walton Center for Planetary Health in 2022. The Office still manages historical data and weather and climate instruments at the previous location at the Arizona State University Community Services Building, 200 E. Curry Road, Tempe, Arizona.

The State Climatologist is the Director of the Office. Two SGSUP faculty are affiliated with the Office (Dr. Anthony Brazel, emeritus professor and former State Climatologist, and Dr. Randall Cerveny, WMO Rapporteur for the World Climate Extremes).

The mission for the Office is to: (1) manage and disseminate climatological information about the State of Arizona, (2) monitor the climate of Arizona and the Southwest, (3) collaborate with state agencies, researchers, stakeholders, and the general public in need of climate data and advisement, and (4) facilitate research aimed at an improved understanding of the spatial and temporal variability of the climate of Arizona.

The Arizona State Climatologist is appointed by the Arizona Governor in an ongoing appointment. Dr. Erinanne Saffell served as the Acting State Climatologist in June, 2021, was appointed by Governor Doug Ducey in July, 2021, and confirmed as the State Climatologist by the Arizona State Senate in April, 2022. Dr. Erinanne Saffell is the 6th appointed State Climatologist for Arizona.

The Office is exclusively funded through Arizona State University. The State Climatologist is currently funded at an 88% level through the School of Geographical Sciences and Urban Planning, College of Liberal Arts and Sciences (the College). In 2022, the Office received additional funding from President's Strategic Initiative Funds of \$205,422 (annually), continuing through 2025. These funds allowed the Office to hire a full-time assistant, Juliana Likourinou, at the end of December, 2022.

Workload percentages for the State Climatologist are 40% Teaching and 48% Service toward State Climatologist and Office duties. The State Climatologist teaches courses on Meteorological Instruments and Measurement, Introduction to Physical Geography, Extreme Weather and Climate, Geography of Natural Resources, and Society and Environment. Budgeted funds cover office support, student worker salaries, travel for the State Climatologist and Assistant, and instrument purchases for teaching and for climate monitoring of various projects in the Phoenix area and the state of Arizona.

Communication Capabilities

The State Climatologist manages the Office's website <http://azclimate.asu.edu/>. The site is structured as a data and educational portal, providing weather data, products, and information related to the climate of the state. The website also includes general climate, historic, and real-time weather information; monthly climate summaries for the state; North American Monsoon data and updates (seasonally); maps and access to Arizona weather stations; and educational, weather safety, and internship resources.

As part of the State of Arizona Hazard Mitigation plan, the Office is responsible for publishing information about Arizona's weather and climate natural hazards on the Office's website, as well as providing information to the general public on weather and climate safety and current weather conditions.

The Office responds to voicemail and email requests on a regular basis. The contact information for the State Climatologist is available through the Office and University websites. Most Office requests are for media interviews or for data and climate information. Requests are typically fulfilled through phone conversations, video conferences, in-person meetings, or email.

Information Services, Products and Tools

Information requests are received throughout the year, but can be influenced by current events in Arizona, the region, the country, or the world. The most common requests are for details on drought, extreme heat, water supply, wildfire, and flood. Media requests are most often received from local and national journalists. Data assistance is typically requested by university researchers, state and local government agencies, law enforcement, the public, private sector companies, the media, and the legal community.

The Office completed a total of thirty-six media interviews and three background interviews in 2022 (total of 39 interviews), which were published through streaming venues, print, and radio platforms. While some interviews occurred in person, the majority of the interviews occurred over video conferencing. Topics covered drought in Arizona and the Southwest, floods in Arizona and the Southwest, the Colorado River, La Nina, Arizona's water supply, winter precipitation, and Monsoon 2022. The Office performed a total of fifteen invited presentations in 2022.

The Office manages two social media platforms: Twitter and Facebook. The Twitter handle is @AZStateClimate and added 382 followers in 2022, with a total of 216.9 thousand impressions (views) on an average of 594/day.

The State Climatologist serves on the Arizona Department of Water Resources Drought Task Force as co-chair of the Drought Monitoring Technical Committee and

weekly advisor to the U.S. Drought Monitor. Monthly, quarterly, and biannual drought reports and maps are generated by the Office and published by the State.

The Office manages a cooperative weather station installed on the grounds of Arizona State University, which also houses the only known operating daily evaporation pan in the Phoenix

metropolitan region. Daily observations are reported to the National Weather Service and the daily evaporation data directly support the city of Tempe in management of Tempe Town Lake. Monthly climate summaries are generated by the Office and published on the State Climate website.

Research, Projects and Publications

- Monthly publication: Arizona Climate Summary (<https://azclimate.asu.edu>)
- Contributing author, NOAA/NIDIS monthly publication: Drought Early Warning System (DEWS), Intermountain West Drought Update
- Contributing author: Arizona Drought Preparedness Annual Report https://new.azwater.gov/sites/default/files/media/2022ADPAR_0.pdf
- Contributing author: three NOAA technical reports Southwest Drought
- Grant approval: President's Strategic Initiative Funds annual \$205,422 to 2025

Outreach and Education

- Co-Chair: Drought Monitoring Technical Committee of State Drought Task Force advising DM authors on Arizona drought conditions
- Member: American Meteorological Society Board on Outreach and Informal Education
- Member: State Drought Interagency Coordinating Group
- Member: State Hazard Mitigation Planning team
- Member: County FEMA Hazard Mitigation planning committees
- Member: Southwest Drought Learning Network (USDA)
- Member: Steering Committee, Urban Climate Research Center, ASU
- Partner: RCE UNESCO Greater Phoenix
- Advisor: Sun Devil Weather and Climate student organization (98 members)
- Invited presentations: Fifteen (video conference and in-person)
- Media interviews: Thirty-nine (video conference and in-person)
- Video production: Three ASU-produced and published videos
- Panel presentation: Southwest DLN 2022 Annual Meeting
- Participant: NSF Convergence Accelerator Managing Water for a Changing Planet
- Total students taught in 2022: 1022 (Introduction to Physical Geography; Extreme Weather and Climate; Society and Environment; Geography of Natural Resources. Introduction to Physical Geography is the largest in-person class in the unit, often with 250 students enrolled each semester.

Monitoring and Impact Assessment

- Monitoring: Assist with maintenance of the former USRCRN climate stations in central and northern Arizona with the National Park Service Inventory and Monitoring Group, and Arizona State University Climate Office. Data are ingested by the Western Region Climate Center and pushed out to MADIS.
- Monitoring: Management and maintenance of ASU Tempe Cooperative Weather Station

- Monitoring: Monthly updates of custom SPI and SPEI gridded indices for long-term drought monitoring for the Governor's Drought Task Force
- Monitoring: Archive data from the Phoenix first-order weather station
- Monitoring: Evaluate, interpret, and publish statewide meteorological variables and parameters providing context to Arizona's weather and climate
- Assessment: Provide climate assessments for Local Drought Impact Groups

California Office of the State Climatologist

ARSCO Annual Report for 2022

State Climatologist:

Dr. Michael L. Anderson

Affiliates:

John Andrew – Executive for Climate Change Programs

Elissa Lynn – Climate Change Program Manager

Jordi Vasquez – South Central Region Climate Specialist

David Rizzardo – Manager Hydrology Section DWR

Sean DeGuzman – Manager Water Supply Forecasting Unit

Ramesh Gautam – Manager California Cooperative Snow Surveys

Angelique Fabbiani Leon – Subject Matter Expert Supporting Forecasting Units

Nina Oakley – Department of Conservation

Benjamin Hatchett – WRCC/DRI and Volunteer for DWR

Affiliation/sponsor: California Department of Water Resources

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Telephone number (916) 699-8378

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<http://calclim.dri.edu> <http://www.wrcc.dri.edu/monitor/cal-mon/>; <https://cww.water.ca.gov>

Social media: <https://www.facebook.com/CADWR> https://twitter.com/CA_DWR

Email address(es) (individual and/or organizational) climate@water.ca.gov

Michael.L.Anderson@water.ca.gov

About the California State Climate Office

The California State Climate Office resides in the California Department of Water Resources. The office of the State Climatologist is housed within the Division of Flood Management Hydrology and Flood Operations Office while the climate change program is housed in the Division of Statewide Integrated Water Management. The Office provides technical expertise in weather and climate interfaces with hydrology and water resources management as well as organizes the Department's contributions to the State's climate change program efforts under the Climate Action Team. In addition, the State Climatologist collaborates with programs including the California Cooperative Snow Surveys, California Nevada River Forecast Center of the National Weather Service, the National Weather Service Weather Forecast Offices Serving California, Western Region Climate Center USDA California Climate Hub, California Nevada Applications Program RISA, NOAA Climate Prediction Center, NOAA Physical Sciences Lab, and local water agencies across California.

The State Climatologist coordinates with the National Interagency Drought Information System Program, the United States Drought Monitor, and provides funding to federal agencies for designated projects and funds researchers at the University of California campuses.

Communication Capabilities

The Office of the State Climatologist provides climate data services through a variety of data portals listed above. CDEC alone has an average bandwidth per day of 22.3GB. This corresponds

- Abrupt Water Year Transitions Diagnosis and Forecast Potential – Collaboration with UC Irvine
- Exploring Extremes on the West Slope Sierra Nevada – Collaboration with UC Davis
- Basin Characterization Model Explorations – Collaborations with USGS/UC Davis
- S2S Forecasts in California and Upper Colorado River – Collaboration with UCLA
- CNAP Collaborations on Fall Precipitation Onset and Extremes Exercises with climate change
- Advancing MODIS-SWE in the Sierra - Collaboration with Noah Molotch team
- Bay Area 10-County Advanced Quantitative Precipitation Information Project – collaboration with NOAA PSL and 10 Bay Area Counties for observations, forecasts and decision support framework

Outreach and Education

The State Climatologist provides outreach talks at numerous meetings around the State including partner workshops, professional societies, and agricultural groups. The State Climatologist sits on the ASCE Hydroclimate Committee, is an associate editor for the ASCE Journal of Hydrologic Engineering and sits on the Steering Committee of NASA’s Western Water Applications Office. The State Climatologist also assists the Bureau of Reclamation with proposal reviews and project reviews. The State Climatologist continued participation in the California Nevada US Drought Monitor Coordination calls hosted by the National Weather Service Weather Forecast Offices. He also continued participation in workshops and activities associated with the NIDIS program. The State Climatologist also supports the DWR’s hydrology basics and climate literacy class.

Monitoring and Impact Assessment

Numerous projects noted above contribute to monitoring the characteristics and impacts of atmospheric rivers, California’s seasonal snowpack, and water management metrics to track a changing climate. At the State level, the State Climatologist contributed material for the 2022 Indicators of Climate Change report from the California Environmental Protection Agency. In the area of Sea Level Rise, the State Climatologist is working with the State’s sea-level-rise leadership team. The State Climatologist and members of the climate change group within the Department of Water Resources continue work to advance an Adaptation Strategy for the Department of Water Resources based on results of their recently completed Vulnerability Study. The 2022 Central Valley Flood Protection Plan update was adopted in November of 2022.

Colorado Climate Center

ARSCO Annual Report for 2022

State Climatologist: Russ Schumacher

Assistant State Climatologist: Becky Bolinger



Staff/Service Climatologists:

Peter Goble, climatologist/drought specialist
Noah Newman, CoCoRaHS education coordinator
Henry Reges, CoCoRaHS national coordinator
Lane Simmons, CoAgMET manager
Steve Hilberg, CoCoRaHS project manager
Dani Talmadge, CoCoRaHS data quality coordinator
Julian Turner, CoCoRaHS web services
Alistair Vierod, CoAgMET technician and data analyst
Nolan Doesken, state climatologist emeritus

Colorado State University, Dept of Atmospheric Science 1371
Campus Delivery
Fort Collins, CO 80523-1371 970-491-8545

<https://climate.colostate.edu>

Russ.Schumacher@colostate.edu

About the Colorado State Climate Office

The Colorado Climate Center (CCC) was established by the State in 1974, through the Colorado State University Agricultural Experiment Station, to provide information and expertise on Colorado's complex climate. Through its threefold program of Climate Monitoring (data acquisition, analysis, and archiving), Climate Research, and Climate Services, the Center responds to many climate-related questions and challenges. The Center monitors climatic conditions on both regional scales and local scales using data gathered by public sources (National Weather Service, USDA, USDI, etc.) and also by monitoring networks deployed by the Center.

Communication Capabilities

The Colorado Climate Center communicates and disseminates climate information via the following platforms:

- Website Services
 - <https://climate.colostate.edu> - the CCC's main website provides info to general Colorado climate information and our office.
 - <https://cocorahs.org> - CoCoRaHS, an international volunteer precipitation monitoring network, is managed through the Colorado Climate Center.
 - <https://coagmet.colostate.edu> - Colorado's state mesonet website.
 - The main CCC website averages approximately 6,000 unique visits and over 10,000 page views per month; the CoAgMET site over 3,000 unique visits and

11,000 page views per month. The various CoCoRaHS websites and apps are more difficult to track quantitatively, but receive hundreds of thousands of visits per month.

- Social Media
 - CCC on Facebook: 2,600 followers (increase of 116 since last report)
 - CCC on Twitter: 4,231 followers (increase of 124 since last report)
- Presentations
 - We typically accept an average of one speaking invitation per week, giving us considerable visibility across the state. During 2022, many of these speaking engagements returned to being in-person, increasing our engagement with different stakeholder groups around the state.
 - Our 40 years of continuous participation in the Colorado Water Availability Task Force is a prime example of how we communicate and disseminate climate information to the state's major water providers, administrators, and utilities.
- Phone and email inquiries – Colorado Climate Center staff regularly receive phone calls and emails with questions about current climate conditions, requests for data, and other climate-related expertise. It's estimated that we respond to around 10-20 data and information requests every month.

Information Services, Products and Tools

- Weekly and Monthly Reports
 - Monthly state climate summaries are sent out to a subscriber list of 470 people.
 - Monthly drought and climate webinars with a typical attendance of 20-30 people.
 - Fort Collins Campus Weather Station – a monthly report of climate conditions at the CCC-maintained campus weather station.
 - Our weekly and monthly reports are all available in our archive: https://climate.colostate.edu/ccc_archive.html
- Latest tools and products developed and added to our websites in 2022 include:
 - Station climate normals for Colorado: https://climate.colostate.edu/normals_stn_select.html
 - Gridded climate normals maps: https://climate.colostate.edu/normals_maps.html
 - Colorado “Climate at a Glance” page: https://climate.colostate.edu/co_cag/index.html
 - Updated data access portal: https://climate.colostate.edu/data_access_new.html
 - Additional CoAgMET maps: <https://coagmet.colostate.edu/maps.html>

Research, Projects and Publications

- Ongoing work to serve the mission of the Center and the needs of Colorado include analyzing and interpreting trends in observed climate, placing significant events in historical perspective, and improving our understanding of climate variability.

- A major effort during 2022 has been toward publishing an updated edition of *Climate Change in Colorado*, with support from the Colorado Water Conservation Board and Denver Water. This project has included updated analyses of observed and projected trends in temperature, precipitation, water resources, drought, hazardous weather, and more. The updated report will be peer-reviewed and published in 2023.
 - Research on soil moisture and drought, funded by NIDIS, continued in 2022. A manuscript was submitted to the Journal of Hydrometeorology on the sources of errors in forecasts of streamflow in Colorado, to examine how important soil moisture information is. The study showed that uncertainties in spring weather were a much larger source of error than soil moisture. This manuscript is under revision as of early 2023.
 - Becky Bolinger, along with several other state climatologists and climate services experts, led a publication on the February 2021 cold outbreak in the central and southern US.
 - Soil moisture sensors were installed at 10 CoAgMET stations in 2022. Previous CoAgMET manager Zach Schwalbe departed for a new position, and Lane Simmons was hired as the new CoAgMET manager in early 2023. Lane has been a long-time part of CoAgMET, maintaining the stations in southeast Colorado, and he has many ideas for enhancing the network in the future.
- Research supported by the Colorado Wine Industry Development Board continued in 2022. This involved the installation of “CoAgMET-lite” stations to monitor temperature in areas with viticultural potential, and preparing a manuscript analyzing regions with potential for growing wine grapes based on PRISM gridded data and observations collected during previous years.
- The CoCoRaHS network continued to grow in 2022, with over 25,000 reporting observers and nearly 5.5 million daily precipitation reports, the most in the history of the network. The CoCoRaHS team has been developing a new Data Explorer, sponsored by NOAA, which will greatly advance the ability of observers to examine their data. The Data Explorer will be released to the public later in 2023.
 - Publications:
 - Rebecca A. Bolinger, Vincent M. Brown, Christopher M. Fuhrmann, Karin L. Gleason, T. Andrew Joyner, Barry D. Keim, Amanda Lewis, John W. Nielsen-Gammon, Crystal J. Stiles, William Tollefson, Hannah E. Attard, Alicia M. Bentley, An assessment of the extremes and impacts of the February 2021 South-Central U.S. Arctic outbreak, and how climate services can help, *Weather and Climate Extremes*, 36, 2022, <https://doi.org/10.1016/j.wace.2022.100461>.
 - Schumacher, R.S., 2022: The Colorado killer tornadoes of November 4, 1922. *Authorea Preprints*, <https://www.authorea.com/doi/full/10.22541/au.166742612.24202428/v3>

Outreach and Education

Many activities and meetings returned to in-person in 2022, along with continued opportunities for virtual engagement. We continued our monthly webinars and monthly presentations at the state Water Availability Task Force meetings. We also presented for a large number of groups

and meetings, including: Colorado Water Congress, Ute Tribes Climate Workshop, Environmental Protection Agency Region 8, Greeley Water, Colorado Fire Chiefs, City of Fort Collins, Colorado Public Utilities Commission, Southwest Drought Learning Network, National Weather Service Integrated Warning Team, Four Corners Air Quality Group, International Fire Weather Exchange, CSU Climate Transitions Dialogue, Colorado Master Irrigators, Southwestern Water Conservation District, Fulbright Enrichment Seminar, National Farm Business Management Conference, and Pueblo County Extension, Akron USDA Field Day, the Institute for Science and Policy of the Denver Museum of Nature and Science, the state recovery task force, the Fort Collins Museum of Discovery, and the American Public Works Association Western Snow and Ice Conference. We also presented at State of the River meetings (sponsored by the

Colorado River District) in Glenwood Springs, Grand County, Summit County, Eagle County, and Carbondale. We also gave guest lectures in ANEQ 472 (animal sciences) and ATS 350 (atmospheric science) undergraduate courses at CSU.

The CCC also continued to be a trusted source of information for local, national, and international media. Russ, Becky, and Peter were all routinely interviewed by a wide variety of media outlets. Along with Noah, they participated in over 115 media interviews in 2022.

CoCoRaHS staff also resumed many of their in-person engagement and education activities, visiting National Weather Service offices and state and regional coordinators, and participating in outreach events at schools, libraries, and museums. Several CoCoRaHS WxTalk Webinars were also held in 2022, along with training webinars for coordinators.

Monitoring and Impact Assessment

The CCC operates and maintains several different weather observing systems:

- Provide comprehensive climate monitoring for the Fort Collins campus weather station. <http://climate.colostate.edu/~autowx/>. 2022 was the 135th year of data.
- The Colorado Agricultural METeorological network, CoAgMET, is a mesonet of over 90 stations, with most reporting data every 5 minutes. The network is supported by station sponsors, the Colorado Water Conservation Board, and the National Mesonet Program.
- CoAgMET is now ingesting and QC'ing 15-minute data for Northern Water stations across northern CO. There are 21 stations available via CoAgMET's website and API.
- We currently own and maintain 17 previous National Weather Service RCRN stations.
- We continue to host, store, and quality control CoCoRaHS data records. Julian Turner manages the CoCoRaHS cyberinfrastructure. In 2022, 5,537 new observers

Connecticut State Climate Office

ARSCO Annual Report for 2020

State Climatologist: Xiusheng Yang

Associate State Climatologist: Richard Anyah

Staff/Service Climatologists:

Affiliation/sponsor: University of Connecticut

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Telephone number: 860-486-0135

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Website(s): <https://csccl.nre.uconn.edu/>

Social media

Email address(es) (individual and/or organizational): xiusheng.yang@uconn.edu; richard.anyah@uconn.edu

About the Connecticut State Climate Office

The Connecticut State Climate Center (CSCC) is recognized by the National Climatic Data Center and the American Association of State Climatologists as a State Climate Office. It provides climate data from 1981 to 2010 on this website. UConn researchers and the public may request data with more detail via the Special Climatic Data Request Form.

The Center is located in the Department of Natural Resources and the Environment, College of Agriculture, Health and Natural Resources, University of Connecticut, Storrs, Connecticut. CSCC works cooperatively with the Northeast Regional Climate Center, which serves 12 northeastern states.

Past support of the service came from various sources, such as the University of Connecticut Research Foundation and the College of Agriculture, Health and Natural Resources. The Center collaborates with national and regional climatic centers, federal and state agencies and various educational institutions.

Director: Xiusheng (Harrison) Yang

Associate Director: Richard Anyah

Communication Capabilities

Website, emails, phones, and fax.

Information Services, Products and Tools

The Connecticut State Climate Center (CSCC) disseminates high quality climate data, information and expertise to UConn, Connecticut agencies and law enforcement officials for research and decision-making purposes. Climate records, obtained from 22 stations throughout the State, include temperatures, degree-days and precipitation amounts. The current statistics are from 1981 to 2010 (to be updated).

CSCC works cooperatively with the Northeast Regional Climate Center, which serves 12 northeastern states. The Center is designated as an official State Climate Office by the National Climatic Data Center and the American Association of State Climatologists.

CSCC works cooperatively with the Northeast Regional Climate Center, which serves 12 northeastern states. The Center is designated as an official State Climate Office by the National Climatic Data Center and the American Association of State Climatologists.

Research, Projects and Publications

N/A

Outreach and Education

CSCC provides data services upon request for university professors and students, government agencies, law enforcement officials, K12 schools, and general public.

Monitoring and Impact Assessment

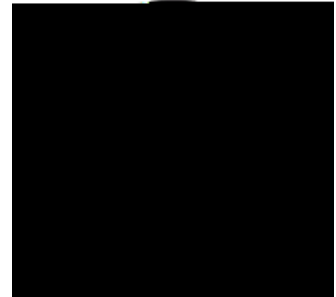
CSCC conducts and publicizes impact analysis via public media, mostly public radio and local newspapers.

State of Georgia Climate Office

ARSCO Annual Report for 2022

State Climatologist: Dr. Bill Murphey
Deputy State Climatologist: Nyasha Dunkley
Service Climatologist: Eleanor Partington

Georgia Department of Natural Resources
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Website: <https://epd.georgia.gov/office-state-climatologist>
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www.twitter.com/gaclimateoffice
Email addresses: Bill.murphey@dnr.ga.gov
Nyasha.dunkley@dnr.ga.gov
Eleanor.Partington@dnr.ga.gov

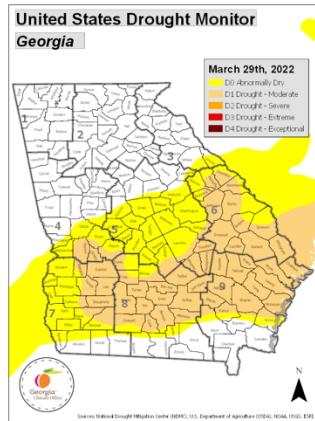


About the Georgia State Climate Office (SCO)

The Office of the Georgia State Climatologist within the Department of Natural Resources functions to collect, disseminate, and interpret climatological and meteorological data. It daily serves the state in responding to public and private entities on issues related to Georgia's climate, as well as offering correspondence with educational institutions as it relates to atmospheric science. An important role of the climate office is to stay apprised of current atmospheric conditions as it relates to (but not limited to) drought, extreme weather events, the ENSO (El Nino-Southern Oscillation) forecast, and the short, middle, and long-term seasonal outlooks. In addition, the office internally produces composite maps containing climatological information, such as precipitation and temperature.

Communication Capabilities

The SCO website contains monthly summaries, meteorological and climatological data resources, and other useful links for public dissemination of information. Specific requests for climatological information and data are received frequently from media, private and public sources and addressed on an ongoing basis. The SCO monitors climate within the state and provides input on air quality, drought conditions and meteorological, hydrological, and agricultural impacts to the U.S. Drought Monitor. The office also seeks to take advantage of the growing influence of social media and thus has established, and maintains, active Facebook and Twitter pages.



Information Services, Products and Tools

The SCO has increased production of available data products for users. The office successfully generates and maintains a GIS display tool for viewing of climate information across the state of Georgia and the Southeast U.S. These plots encompass climate-related parameters, including mean temperatures and anomalies, rainfall amounts and departures, stream flows, archived storm reports, and other specialty plots for high impact weather and climate events affecting Georgia. Future goals are to include as many of these plots as possible on the SCO website such that members of the public will have access to these data.

Research, Projects, and Publications

An additional function of the SCO is to provide climate data and analysis for requested use in research and educational projects. The data provided by the SCO has been utilized in academic research for universities across the region. The office provided input from Georgia for use in the state summary of the National Climate Assessment report. The National Climate Assessment, generated by a team of more than 300 scientists and guided by a Federal Advisory Committee, provides an in-depth look at climate-related impacts in the U.S. The State Climatologist frequently presents to the Board of Directors of the Georgia Department of Natural Resources (DNR) on the state of the climate in Georgia and functions of the climate office.

Outreach and Education

The SCO upholds an outreach focus. Staff participates, to the extent possible within staffing and budget limits, in as many outreach efforts as possible. These outreach efforts range from elementary school presentations, children 4-H programs, guest lectures at various Georgia universities and participation on climate-related discussion panels. The office maintains very open communication with news media outlets across the entire state in addition to maintaining close collaboration with regional partners such as the National Weather Service local and regional forecasting offices. Meteorological and climatological data and analyses are disseminated via the internet, email, telephone, regular mail and in person through interviews and presentations.

Monitoring and Impact Assessment

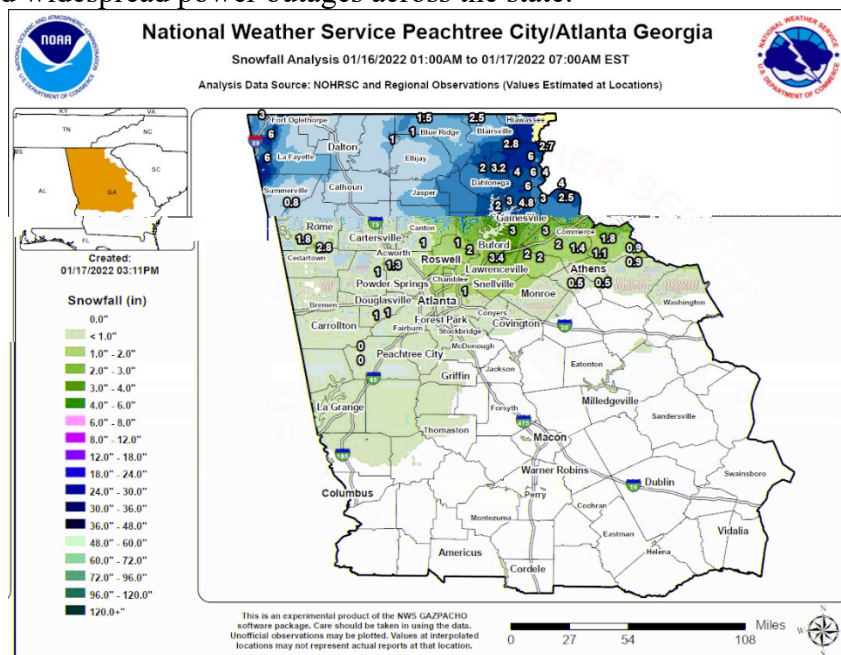
The SCO, in collaboration with the Air Protection Branch of the Environmental Protection Division and Georgia Institute of Technology, has forecasted levels of ozone and particle pollution

throughout the state of Georgia since 1996. Data are used to determine compliance with six criteria pollutants and to evaluate the need for any special controls for various other pollutants. Data are used to calculate the Air Quality Index (AQI) and update the information every hour to protect public health. A future goal of the office is to enhance automated archived and real-time data on our website to assist in case study analysis and monitoring climate conditions within the state.

Review of 2022 Impactful Events

Winter Storm – January 2022

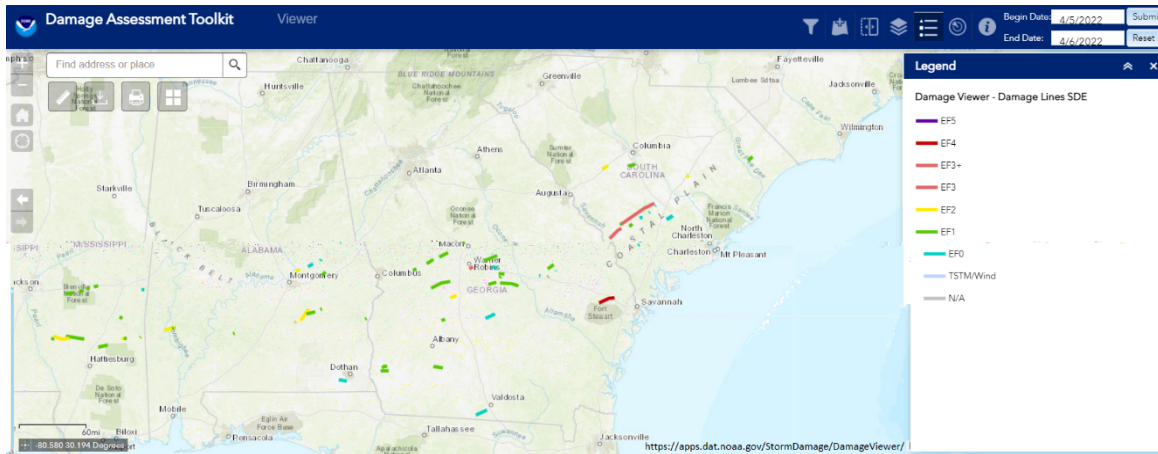
A winter storm during the middle of January brought snowfall to areas of North Georgia, including Atlanta, which had not seen snow since 2018. An area of low pressure tracked through the region on January 15th and 16th encountering a wedge of cold air which allowed for a wintry mix of ice, rain, and snow for areas across Georgia. Colder temperatures in Northeast Georgia caused snowfall amounts to be highest in that region. According to the National Weather Service at Peachtree City, this system ended the second longest snow drought of Atlanta, with 0.3" of snow officially recorded. Wind gusts accompanying the passing of the system also caused numerous downed trees and widespread power outages across the state.



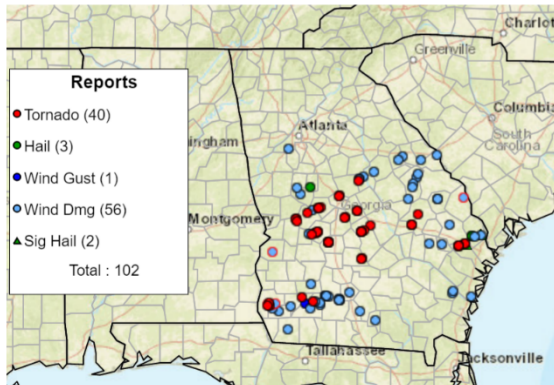
Severe Weather – April 2022

Two rounds of severe weather outbreaks occurred on April 5th and 6th due to warm, moist, and unstable air masses. Tornadoes, hail, and high winds caused severe damages across Georgia. On April 5th, an EF-3 tornado was reported in Houston County with the peak winds estimated to be 160 mph, causing one injury. An EF-4 tornado was reported in Bryan County on April 5th with the estimated peak wind speed of 185 mph, causing one fatality and 12 injuries. This was the second

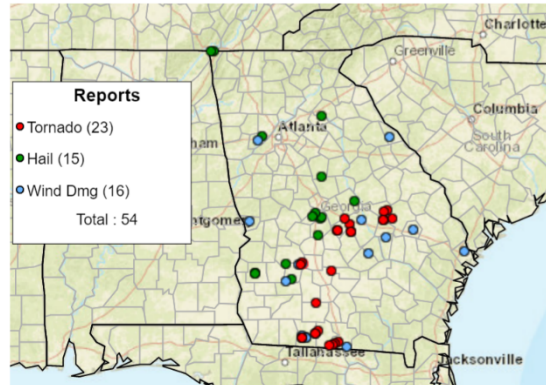
EF-4 tornado reported in a decade and the 11th in Georgia since 1950. The previous EF-4 occurred on March 25th, 2021, and traveled through Heard, Coweta, and Fayette County.



Storm Prediction Center Local Storm Reports



April 5th, 2022



April 6th, 2022

EF4 Tornadoes in Georgia

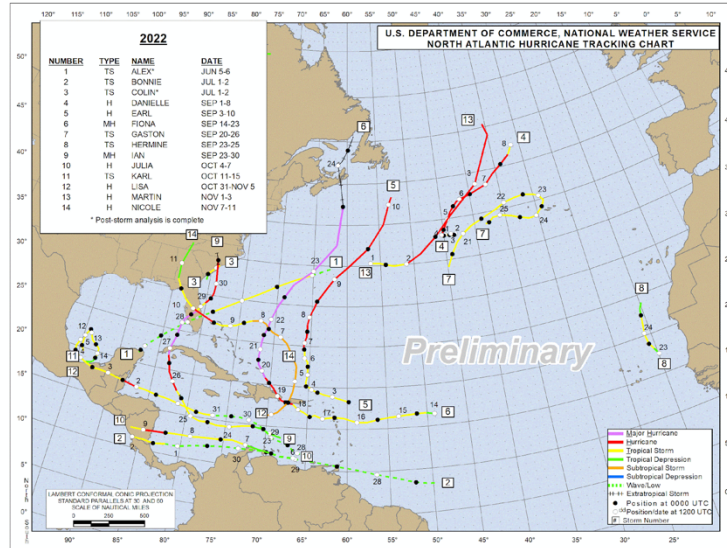
DATE	COUNTIES AFFECTED	FATALITIES	INJURIES
4/5/2022	BRYAN	1	12
3/25/2021	HEARD/COWETA/FAYETTE	1	0
4/27/2011	CATOOSA	7	30
5/11/2008	MCINTOSH	0	9
3/27/1994	FLOYD/BARTOW/CHEROKEE/PICKENS	3	Unknown
11/22/1992	CHEROKEE/COBB	0	46
11/22/1992	PUTNAM/GREENE	5	86
4/3/1974	GORDON/WHITFIELD/MURRAY	9	67
4/3/1974	PICKENS/DAWSON/LUMPKIN	6	30
4/3/1974	FANNIN	0	0
4/30/1953	HOUSTON	18	300

Data from https://www.weather.gov/ffc/ef4tornado_history

2022 Atlantic Hurricane Season

The 2022 Atlantic hurricane season ended on November 30th with near normal activity in terms of the number of named storms and hurricanes, but slightly below average in terms of the

number of major hurricanes, according to the National Hurricane Center. Fourteen named storms formed in 2022, eight of which became hurricanes and two became major hurricanes, rated as a category 3 or higher on the Saffir-Simpson Hurricane Wind Scale. Two hurricanes, Martin and Nicole, formed in the Atlantic Basin during November, while Lisa developed in late October and became a hurricane early in November.



Hawaii State Climate Office

ARSCO Annual Report for 2022

State Climatologist: Dr. Pao-Shin Chu
Assistant State Climatologist: Bo-Yi Lu
Staff/Service Climatologists:

Hawaii State Climate Office
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About the Hawaii State Climate Office

The Hawaii State Climate Office (HSCO) is a member of the American Association for State Climatologists and a partner with the National Oceanic and Atmospheric Administrations' National Centers for Environmental Information (NOAA/NCEI). Established in 2000, it is situated in the Department of Atmospheric Sciences at the University of Hawai'i in Mānoa. Our primary service is to provide Hawaii climate and weather-related data and information (e.g., precipitation, temperature, and wind speed/direction) in a timely manner.

Communication Capabilities

On our website (<http://www.soest.hawaii.edu/MET/Hsco/site.htm>), we offer climate reports and several key data connections, such as those for hydrology and climate change indicators. For those who are unable to locate the information needed on the website, we list contact details including email and phone number.

Information Services, Products and Tools

We respond to data requests for hourly/daily/monthly/annual temperature, wind, and precipitation for stations from a variety of sources, including government organizations, academic institutions, and individual individuals. We also assist the NWS in keeping track of daily rainfall statistics. For the past 19 years, we have assisted the State Department of Business, Economic Development, and Tourism (DBEDT) in updating their annual State Data Book.

Research, Projects, and Publications

Our previous studies examined the various impacts of ENSO diversity on the Hawaiian regional climate variability in the wet season (Lu et al., *J. Climate*, 33, 9929-9943, 2020). Our most recent study analyzed the impact of the Pacific Meridional Mode (PMM) on ENSO and Hawaii climate. The second EOF mode of detrending SSTA over the tropical Pacific could represent the PMM, which reaches peak strength in the spring season. With regard to a (+) PMM phase in spring, there was an isolated warming over the equatorial central Pacific (CP) and extensive warming over the equatorial central and eastern Pacific (EP) in the prior and posterior winters, respectively. Namely, PMM facilitates the development of CP and canonical El Niño in the prior and posterior winters,

respectively, related to the peak PMM season. Such an impact will further alter precipitation in Hawaii. Moreover, PMM also has a direct impact on Hawaii regional climate variability, which is distinct between the winter and spring seasons. For the (-) PMM-phase, anomalous westerly winds around the islands develop in winter and the lee sides of the island chain experience a significantly wetter environment. In the spring season, warm and wet atmospheres occur around the Hawaiian Islands, inducing a state-wide enhanced rainfall pattern.

Outreach and Education

In 2018, Dr. Chu was invited to be a member of the Hawai‘i State Hazard Mitigation team under the Hawai‘i Emergency Management Administration, which consists of government officials from federal, state, county, and city, emergency management, planners, and researchers. The team meets regularly to discuss various kinds of natural hazards in Hawai‘i (e.g., volcanic eruptions, flooding, hurricane) and its vulnerability assessment. Dr. Chu assisted the State Hazard Mitigation team to update their comprehensive 2018 Plan. After serving for five years, Dr. Chu was recently invited to continue to serve on the Hazard Mitigation team for the next five years. Moreover, Dr. Chu also serves as a member of the State-wide Drought Council. Dr. Chu recently published a book titled “Climate Variability and Tropical Cyclone Activity” with Dr. H. Murakami of NOAA/GFDL, Princeton, New Jersey. The book came out in 2022 with 320 pp and will be used as a text for a graduate-level course to be offered at the University of Hawai‘i for the first time in fall 2023.

Monitoring and Impact Assessment

We help the NWS to record daily rainfall data at the University of Hawai‘i in Manoa. Recently, in response to a request from a dam owner, a dynamical downscaling approach with the latest WRF model was used to assess the probable maximum precipitation amounts for a watershed on Oahu.

Idaho Climate Services



University of Idaho
Extension

State Climatologist: Russell Qualls, Ph.D., P.E.

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Email: rqualls@uidaho.edu

Website: <https://www.uidaho.edu/extension/climate-services>

About Idaho Climate Services

Idaho Climate Services connects users with present and historical climate and weather data, near-term weather outlooks and general climate information for Idaho.

Idaho Climate Services (ICS) is the *American Association of State Climatologists (AASC) Recognized State Climate Office (ARSCO)* for Idaho. ICS was established in 1978 by a Memorandum of Understanding among the National Climate Data Center (now National Centers for Environmental Information, NCEI), the National Weather Service Western Region, and the University of Idaho. ICS gained **ARSCO** recognition in 2001. We are sponsored by University of Idaho Agricultural Research & Extension.

Communication Capabilities

We provide access to data and other resources relevant to Idaho water and climate through our website, <https://www.uidaho.edu/extension/climate-services>. Our office can be contacted through the email and telephone listed above.

Information Services, Products and Tools

The ICS website provides access to a map of current weather station observations across the Idaho, NWS weather alerts, and access to a number of resources and tools including historical weather data, drought maps, mountain snowpack conditions, as well as streamflow, and evaporation data.

Research, Projects and Publications

Water is critical to the state of Idaho. Agricultural irrigation represents the dominant consumptive use water in the state; most of this water accumulates as mountain snowpack in the winter. ICS conducts research on satellite remote sensing of snow in order to provide model input for simulating, forecasting, and assessing possible outcomes of climate change on snowmelt runoff.

Dr. Qualls also conducts research on evaporation which impacts the demand side of water, for crop irrigation. Several journal articles were published this year on this topic.

Szilagyi, J., N. Ma, R.D. Crago, and R.J. Qualls, Power-function expansion of the polynomial complementary relationship of evaporation, *Water Resources Research*, 58(11): 1-20, 2022WR033095, <https://doi.org/10.1029/2022WR033095>

Crago, R., Qualls, R.J., Szilagyi, J., Complementary relationships for evaporation tested at different spatial & temporal scales, *J. Hydrology*, 608:1-12, <https://www.sciencedirect.com/science/article/pii/S0022169422001500>, 2022.

Outreach and Education

ICS delivered a number of research, outreach and education seminars this year. Dr. Qualls participated in a number of media interviews, especially addressing the exceptional drought and wildland fires which occurred in the Pacific Northwest. (see also “Monitoring and Impact Assessment” below).

Selected Presentations:

Qualls, R.J., and C. Woodruff, Inter-Annual Temporal Repeatability of Snowmelt Patterns Derived from Remote Sensing, Abstract C35E-0936 presented at 2022 Fall Meeting, AGU, Chicago, IL, December 14, 2022.

Qualls, R.J., (**Invited**) 2022, [Idaho Weather 2022 & 2023 Forecast](#), presented at the UI Extension Ag. Outlook Webinar, December 13, 2022.

Qualls, R.J., Low-cost water wells for developing countries, Abstract 1036339 presented at 2022 Frontiers in Hydrology meeting, AGU, San Juan, Puerto Rico, June 19-24, 2022.

Media Interviews:

Idaho News 6, Geneva Zoltek, Summer 2022 Excessive Heat, October 19, 2022.

Idaho Press, Carolyn Komatsoulis, “[Electric vehicles ‘are the future,’](#) but how fast will Idaho adopt them?” August 7, 2022

High Country News, Caroline Tracey, Anticipated Impacts of Possible “Climate Emergency Declaration” by President Biden, July 20, 2022

Bingham News Chronicle, Logan Ramsey, Climate Change Impacts on Drought, March 16 & 22, 2022.

Monitoring and Impact Assessment

Dr. Qualls serves on the Idaho Drought Committee, which meets regularly throughout the year to assess current drought conditions statewide and provide guidance and recommendations to the [US Drought Monitor](#) regarding the spatial distribution of drought severity across the state.

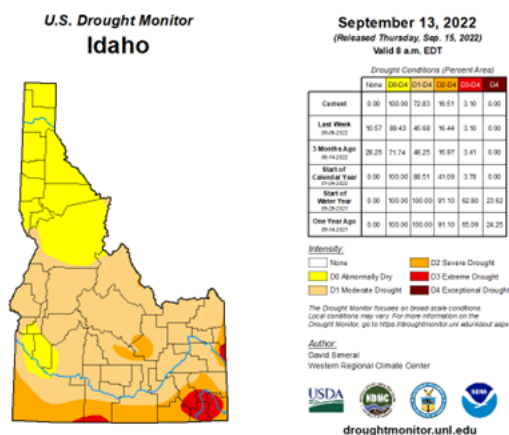
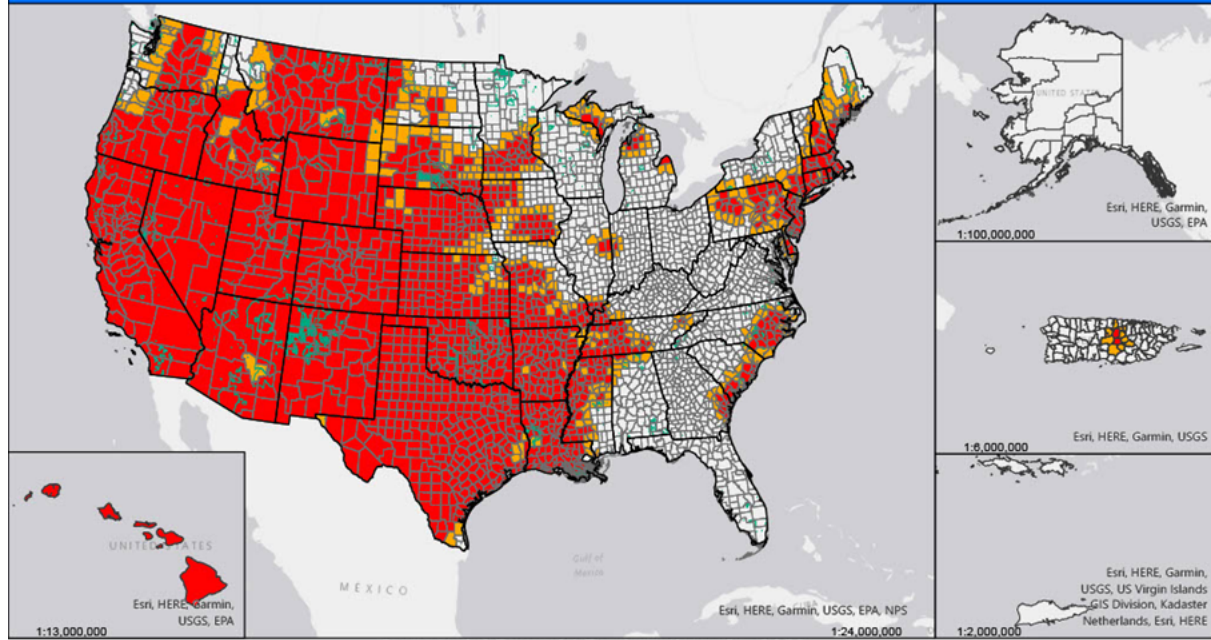


Figure 1. US Drought Monitor drought category designations for Idaho, September 13, 2022

Fig. 1 shows that in September 2022, drought encompassed 100% of Idaho but its severity had drastically reduced from a year earlier (compare first and last lines in the table in Fig. 1).

2022 Secretarial Drought Designations - All Drought



**Secretarial Drought Designations for 2022
Disaster Incidences as of April 12, 2023**



United States Department of Agriculture
Farm Service Agency
Program Delivery/Safety Net Division
April 12, 2023

- State Boundary
- County Boundary
- Tribal Lands
- Primary Counties: 1,355
- Contiguous Counties: 423

The

2014 Farm Bill criteria specifies using USDM drought category data as a basis for [USDA Secretarial Drought Designations by county](#) and to determine eligibility for livestock forage disaster financial aid. Despite the late summer reduction in drought conditions for Idaho, USDA Drought declarations were in effect for most of the western US, including more than 20 counties in Idaho in 2022. In Idaho only the northern panhandle was free of drought declarations (Fig. 2).

Fig. 2. US Secretary of Agriculture county drought designations for 2022 as reported in April 2023.

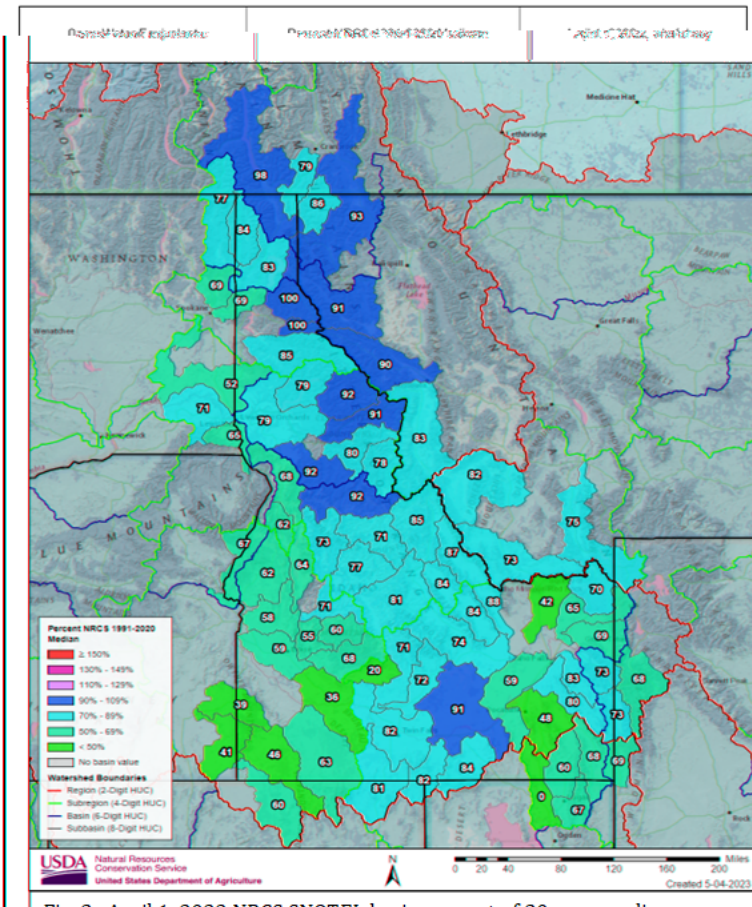
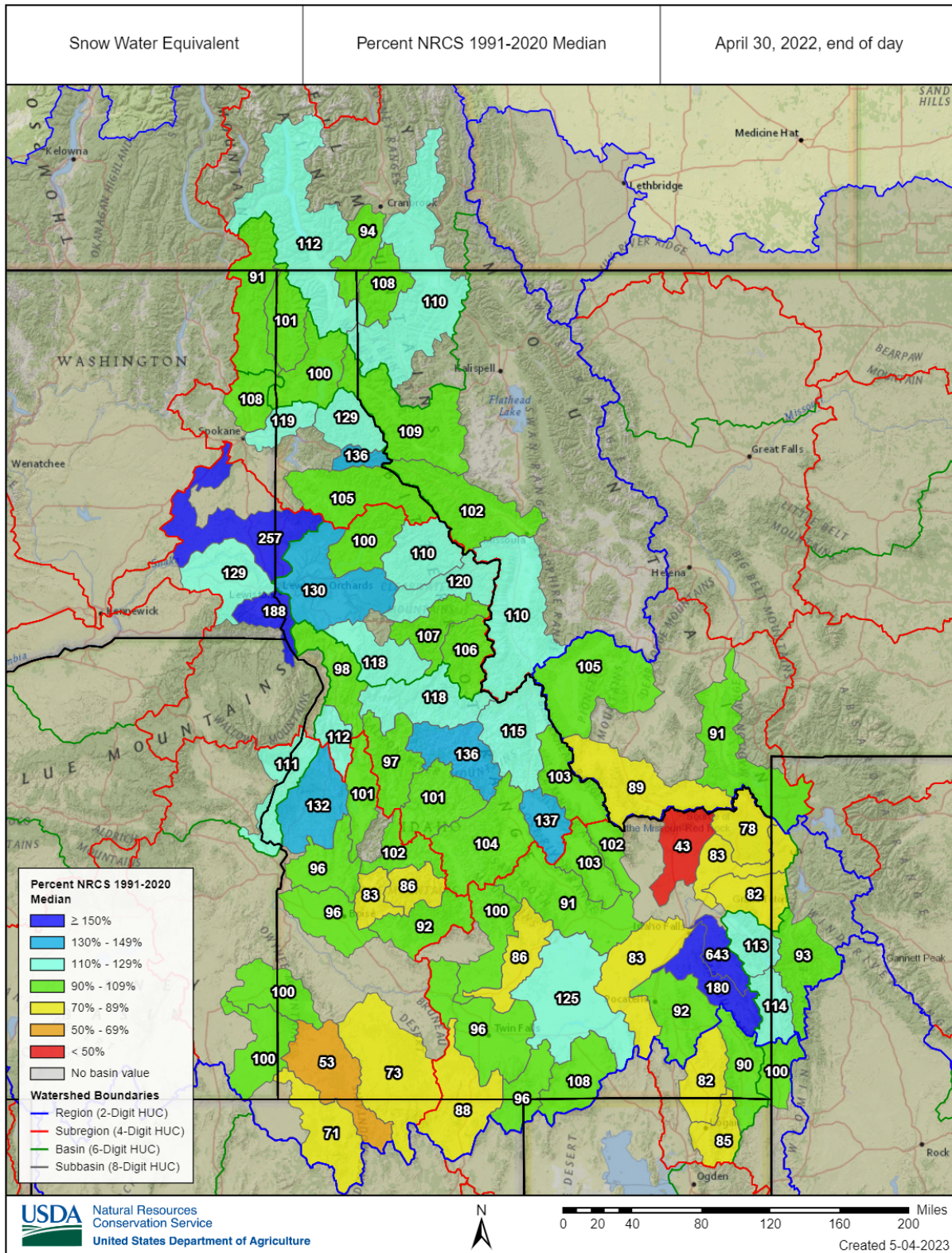


Fig. 3. April 1, 2022 NRCS SNOTEL basin percent of 30-year median snow water equivalent.

On April 1, 2022, snowpack conditions across the state were not looking very good except in the northeastern panhandle (Fig. 3). These conditions following the severe drought conditions of 2021 resulted in drought declarations in the lower two-thirds of Idaho. However, cooler wetter conditions throughout the spring after April 1st maintained and even increased the snowpack (Fig. 4), helping to alleviate some of the ongoing drought.

Fig. 4 April 30, 2021 NRCS SNOTEL Basin Percent of 30-Year April 30 Median Snow Water Equivalent.



Climate Outlook

The [Climate Prediction Center](#) (CPC) Outlooks for the summer 2023 in Idaho suggest that above average temperatures statewide and below average precipitation in the panhandle are likely.

The Pacific Northwest Drought Early Warning committee prepared a [PNW DEWS 2022 Pacific Northwest Water Year Impacts Assessment](#) (Idaho Climate Services: Contributor) which summarizes conditions and impacts across the Pacific Northwest.


Acknowledgements:

Research at ISCS is supported in part by NIFA grants IDA01584 and IDA01721, and Idaho Water Resources Research Institute (IWRRI) and the DOI USGS grant number G16AP00050.

Illinois State Climatologist Office

ARSCO Annual Report for 2022

State Climatologist: Trent Ford
Assistant State Climatologist: N/A
Staff/Service Climatologists: Bridgette Mason

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 @ILClimatologist



About the Illinois State Climate Office

The Illinois State Climatologist Office provides weather and climate information and interpretation for Illinois citizens, government agencies, industries, and special interest groups. The Office conducts climate science research ranging from fundamental to applied, monitors current conditions, and studies future climate change, overall acting as the state's authoritative spokesperson on climate science.

Communication Capabilities

The SCO maintains an active website that provides regular weather and climate updates, historical climate information, educational materials, drought monitoring resources, among many other services: <https://stateclimatologist.web.illinois.edu/>. The State Climatologist also maintains an active media profile, conducting 150-200 media interviews each year on various weather and climate topics. The Office contributes to several special publications and newsletters for University and State special interest groups, including Illinois Extension. The SCO maintains an active social media presence as well, primarily via Twitter (@ILClimatologist) and YouTube. The office regularly releases press releases and updates to a wide audience on current or recent weather and climate conditions and near-term outlooks.

Information Services, Products and Tools

The SCO maintains updated weather observations for Champaign-Urbana, including the C-U weather almanac, and also maintains the Illinois Drought Monitoring dashboard: <https://stateclimatologist.web.illinois.edu/drought-in-illinois/>. Otherwise, the SCO serves as a point

to connect those needing weather and climate information with regional and federal service providers, such as the Midwestern Regional Climate Center.

Research, Projects, and Publications

The SCO is actively participating in several funded research projects from the National Science Foundation, National Oceanic and Atmospheric Administration, and US Department of Agriculture. Provided here are snapshots of just three of the active research projects led or co-led by the SCO:

1. The SCO led a project examining the historical and future changes in precipitation extremes in the Midwest, in collaboration with the University of Nebraska-Lincoln and NIDIS. The project has provided first evidence of recent increases in precipitation variability and “transitions” in wet and dry extremes in parts of the Midwest. The project also developed the first projections of potential future changes in transitions between precipitation extremes in the Midwest (Ford and Chen, 2021; Chen *et al.* 2023)
2. The SCO is co-leading a project developing drought early warning systems for reducing drought impacts to urban trees, focused on the Chicagoland area. In collaboration with the Morton Arboretum and dozens of urban foresters and municipal managers across Chicagoland, the project is refining planting recommendations and species-specific guidance for building a drought resilient urban canopy. The SCO and Morton Arboretum – with regular guidance and feedback from municipal managers – are building a tool to provide neighborhood-scale tree drought response for more targeted watering strategies, which will help with limited municipal budgets for tree management.
3. The SCO is leading a project to better understand the impact of winter warming (past and future) on chill hour accumulation and spring freeze risk to peach and apple crops in the Midwest. In collaboration with Illinois Extension, the project has developed historical trends, projected changes, and targeted recommendations for peach and apple grower adaptations to changing winters in the Midwest (Ford *et al.* in review).
4. The SCO led or co-led weather, climate, and climate change sections of the Illinois State Hazard Mitigation Plan, the Illinois State Water Plan, the Illinois State Energy Security Plan, and for multiple county- or state-level disaster assistance requests. The 2023 State Hazard Mitigation Plan, in particular, is the first in Illinois’ history to include an extensive reflection on climate change, its impacts to hazards and vulnerability, and recommendations for community and sector adaptation.

Ford, T.W., Chen, L., and J.T. Schoof, 2021: Variability and transitions in precipitation extremes in the Midwest United States. *J. Hydrometeorol.*, 22, 533-545.

Chen, L., Ford, T.W., and E. Swenson, 2023: The role of circulation patterns in projected changes in spring and summer precipitation extremes in the US Midwest. *J. Climate*, 36, 1943-1956.

Ford, T.W., Wahle, E., and L. Chen: Historical and projected changes in winter chill hours in the Midwest: Implications for peach and apple crops. *Ag. For. Meteorol.*, (in review).

Outreach and Education

The SCO maintains an active outreach profile, including conducting dozens of public speaking events on a variety of topics, 150-200 media interviews, contributing to several sector- or special

interest newsletters, and providing climate data, information, and interpretation for dozens of requests annually. The SCO also regularly engages in weather and climate education. This past year we hosted 5 K-12 school groups at our mesonet and National Weather Service station in Champaign. The State Climatologist visited over a dozen K-12 classrooms and talked with students about weather, climate, and climate change. Members of the SCO have given 6 guest lectures in classes and seminars around the University of Illinois, Illinois State University, and Southern Illinois University-Carbondale in the last year. The State Climatologist is collaborating with Illinois Extension to help develop the Climate Stewards program, which will provide adult education in climate change, environmental health, and adaptation and mitigation solutions. The SCO hosted the first ever Illinois Climate Workshop in September 2022, which brought together local-, state-, and federal partners around the Midwest to discuss climate information and service needs. The workshop was widely seen as a success and has spawned new collaborations and communication partners for monitoring and impact assessment.

Monitoring and Impact Assessment

The SCO regularly monitors climate and drought conditions across the state, and reports conditions and outlooks in several written, online, and TV/radio outlets. The State Climatologist leads the state's US Drought Monitor team, which meets weekly to discuss current conditions and recommendations for the Drought Monitor. The SCO maintains strong relationships with all 5 National Weather Service offices serving Illinois, federal partners including FEMA Region 5 and the USDA Climate Hub, and state partners including DNR and Department of Ag, and regularly communicates information and impact assessment before, during, and after significant events.

Indiana State Climate Office

ARSCO Annual Report for 2021

State Climatologist: Dr. Beth L. Hall

Assistant State Climatologist: N/A

Staff/Service Climatologists: Jonathan Weaver, Austin Pearson, Hans Schmitz, Bob Autio

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About the Indiana State Climate Office

The Indiana State Climate Office (IN-SCO) is located at Purdue University in West Lafayette, Indiana. It has been around since the mid-1950 when it was part of the Climatological Division of the Weather Bureau and then transitioned to the Agronomy Department within the College of Agriculture in 1973. Due to its location within the Agronomy Department, agricultural climate has been the primary driver for outreach, extension, and online tools.

Dr. Beth Hall has served as the director of the IN-SCO since 2019 and is the designated state climatologist. Jonathan Weaver is the applied data analyst and online applications developer. He supports the data programming, visualization, and online delivery of climate tools and information. Austin Pearson is the service climatologist and provides significant support with the IN-SCO outreach and stakeholder coordination. Hans Schmitz and Bob Autio help with social media and the Purdue Mesonet.

Communication Capabilities

The IN-SCO website, <https://ag.purdue.edu/indiana-state-climate/about/>, was overhauled in 2019. More information about tools and resources on the website can be found in the next section. However, this is where users can submit online data requests, call the main office line, and monitor climate conditions across the state. The IN-SCO social media was revitalized on both Facebook and Twitter under the leadership of Austin Pearson and Hans Schmitz.

Information Services, Products and Tools

The IN-SCO utilizes IT servers and support from Purdue University. This includes access to a research data server and a College of Agriculture database that serves to store Purdue Mesonet data, metadata, and research data collections.

Products on the IN-SCO website currently include 7-, 30-, and 90-day maps of actual and departure temperature (max, min, mean), precipitation (including percent of mean) provided by the MRCC. Additionally, spring and fall climatological frost/freeze dates (10th percentile and average) and growing season maps are provided. Tools added in recent years include a potential evapotranspiration tool based upon data from the Purdue Mesonet, along with several general graphs such as a tornado time series, freeze-thaw events at the Indianapolis Airport, and tools that looked at the number of windy days per year and changes in solar radiation.

Data that is provided through the IN-SCO website include historical and near real-time access to the 13 stations within the Purdue mesonet (temperature, precipitation, solar radiation, winds, humidity, soil temperature) along with links to other data sources such as CoCoRaHS, ASOS, MRCC's cli-MATE online data portal, and NOAA's Climate Prediction Center. This past year, the Purdue Mesonet Data Hub (the website for the mesonet) was expanded to include information about the mesonet, how others can be involved, the metadata of each of the station's sensors, etc.

The IN-SCO does offer a data request link through its website. Approximately two-thirds of the requests are for data from the Purdue Mesonet and the other third is data accessible through the Midwestern Regional Climate Center.

To enhance collaboration with county Extension personnel for monitoring drought conditions for the state drought task force, an online form and mapping system was created and operationalized in 2021. This allows anyone to submit their county recommendation for US Drought Monitor drought state and comments regarding impacts and conditions. Output is displayed in both map and tabular formats. Weekly emails are sent to all Agricultural and Natural Resource county Extension agents that provide an quick overview of recent conditions, forecasts, and climate outlooks, as well as requesting the participation in this online county drought status and impacts tool (<https://ag.purdue.edu/indiana-state-climate/indiana-drought-conditions/>).

Research, Projects and Publications

One project was funded in 2021 that the IN-SCO was sole principle investigator on and was an extension on a previous project. Funded by the National Integrated Drought Information System, this project continued to explore the development of a flash drought early warning risk tools. Utilizing machine learning methodology, the tool builds algorithms based upon data from the North American Regional Reanalysis and historical flash drought incidences to then be applied to operational forecasts out to 14 days. The final online product shows levels of risk that a flash drought could develop in this time period. In 2022, this tool was implemented operationally in a test environment to assess how well it verified across much of the central and eastern U.S. Final reports and publications on these findings are expected in 2023.

In 2022, the IN-SCO wrote nearly 20 articles across three different Purdue Extension newsletters (*Fancy Fruits; Pests & Crops; Vegetable Hotline*). Combined, these newsletters have a reach of over 4500 subscribers. These articles often summarized the climate conditions over the past several weeks, weather and climate conditions to be aware of over the next few weeks, what the NOAA CPC climate outlooks were indicating, and often an online tool that was suggested to help improve decision making. The IN-SCO was also the chief editor of *The Hoosier Observer* – the monthly e-newsletter sent to all Indiana CoCoRaHS observers.

Outreach and Education

Over 12 presentations were given by the IN-SCO across Indiana. These presentations ranged from the State of the Climate presentation that was given to Extension personnel across the state to CoCoRaHS training, to climate change and how it impacted Indiana. This was fewer than in previous years due to the transitioning from pandemic limited travel.

Approximately 10 interviews and/or media engagements were provided in 2022 that often supported articles in agricultural trade journals.

As one of the state CoCoRaHS coordinators for Indiana (in partnership with NWS-Indianapolis and NWS-Northern Indiana), the IN-SCO leads the production and distribution of the CoCoRaHS newsletter along with monthly newsletter reminders to fill in missing data from the previous month. Production of these monthly newsletters started fall 2019 and have resulted in an increase in the number of observers submitting complete months of data. The newsletters have also improved engagement among the state CoCoRaHS community.

In recent years, participants from the National Weather Service, state Department of Natural Resources, and state Department of Homeland Security and Emergency Management have organized a state drought team. When drought seems to be developing, weekly conference calls are held to get input from across the state, including the IN-SCO. The IN-SCO leads the calls for this task force.

Monitoring and Impact Assessment

Climate monitoring for Indiana is supported by the Purdue Mesonet and the Indiana Water Balance Network – two state mesonets managed and operated by Purdue University and Indiana University. The IN-SCO is the manager of the Purdue Mesonet and has been working with the IWBN manager since 2019 to explore ways in which the two mesonets could support each other in a public-facing “Indiana Mesonet” that would still maintain each one’s unique strengths and missions. Collaboration is leading toward the development of an independent Indiana Mesonet Advisory Board to help guide both mesonets and serve as advocates for state funding. The IN-SCO is leading this effort.

State of Kansas Climate Office

ARSCO Annual Report for 2022

State Climatologist: Dr. Xiaomao Lin

Assistant State Climatologist: Matthew Sittel

Staff/Service Climatologists: Christopher Redmond, Mesonet manager; Dan Regier, Web developer; Randy Mai, Technician; Jake Thompson, Technician

Affiliation/sponsor: Kansas State University, Department of Agronomy

Street Address: 2004 Throckmorton Plant Science Center, 1712 Claflin Road

City, State Zip code: Manhattan, KS, 66506

Telephone number: 785-532-1087

Fax number: 785-532-6094

Website(s): climate.ksu.edu; mesonet.ksu.edu

Social media: Twitter: [@ksmesonet](https://twitter.com/ksmesonet), Facebook: [@kansasmesonet](https://www.facebook.com/kansasmesonet)

Email addresses: xlin@ksu.edu, kansas-wdl@k-state.edu

About the State of Kansas Climate Office

The Kansas Office of the State Climatologist continues in its 47th year of operation. As a part of the Department of Agronomy at Kansas State University, the office receives funding from both the College of Agriculture and the Kansas Research and Extension Service to support both state/federal agency needs while providing a platform for undergraduate and graduate education.

In 2022, the Kansas Climate Office currently supports four full time positions of assistant State Climatologist, Kansas Mesonet manager, a web programmer, and weather station technician. We also support a few part-time student assistants. For graduate students and visiting scholars, our Office has three active Ph.D. graduate students and two visiting scholars. We are recruiting two post-doctoral scientists for conducting wheat research programs at K-State.

The Kansas Climate Office maintains strong relationships with the seven National Weather Service Offices that serve Kansas and Southern/Central Region Offices. This collaboration has included a Kansas Climate Interagency Workgroup, support for Cooperative Observer Network awards, education seminars/training, office visits, Kansas Interagency Wildfire Council, outlook products and other activities. Our staff also participates heavily in the Community Collaborative Rain Hail and Snow Network (CoCoRaHS) program. Through our extensive recruitment efforts, over 150 new CoCoRaHS observers were added in 2022, our highest total since joining the program in 2003. The office also enjoys a collaborative working relationship with the High Plains Regional Climate Center, National Drought Mitigation Center, Drought Early Warning Systems, and the USDA Southern Climate Hub. These collaborations include participation in regional workshops, drought updates, submission of monthly climate reports for Kansas and transfer of data from our Mesonet for use by the Regional Climate Centers. The office also works extensively with the Kansas Water Office, Kansas Forest Service, Kansas Department of Emergency Management, Kansas Department of Agriculture, Kansas Department of Health and Environment, Kansas Department of Health and Aging and Disability, and the United States Army Corps of Engineers.

In addition, the Kansas Office of the State Climatologist serves as the home of the Kansas Mesonet, a network of 80 automated environmental monitoring stations. Twelve sites have climate records of over 30 years, dating back as far as 1985. The continued operation of the Mesonet has been made possible thanks to collaborations with countless agencies both within and outside the state of Kansas.

Communication Capabilities

The Kansas Office of the State Climatologist provides weather and climate information through a variety of means. Communication by way of telephone, social media and email are common, but our primary delivery of information is via the web. In 2022, there were over 302 requests for information received by written and verbal communication. Our office participated in over 80 outreach events reaching at least 4,200 people without considering media or online interactions. This does not include the 70+ radio spots and interviews done through the year with an unknown but significant audience reach. Our main website (<http://mesonet.k-state.edu>) continues to provide real-time environmental data, as well as historical summaries, and various products for end users. In 2022, the Mesonet website has reached up to 1.4 million views by over 240,000 individuals. Both these numbers are more than double the 2021 counts. The climate website (<http://climate.k-state.edu>) continues to provide numerous tools and data resources for Kansans as well.

The Climate Office maintains a social media presence through frequent tweets on Twitter (~3,500 followers). In June, 2022, the office added a Facebook page (~850 followers) to reach even more people.

Information Services, Products and Tools

The office provides information services in a variety of ways. First, we have delivered a monthly Ag-Climate Update Bulletin for Kansas stakeholders including climate, crop, and water information. Secondly, the office provided regular or irregular interviews by local news agencies and media outlets. For example:

June 17, 2022: Kansas City Star,
[Did climate change kill 2000 Kansas cows? Follow science](https://www.kansascity.com)
<https://www.kansascity.com> ›

June 23, 2022: The Iola Register,
<https://www.iolaregister.com/opinion/editorials/lessons-to-be-taken-from-2000-dead-cattle>

December 20, 2022, Miami County Republic, https://www.republic-online.com/news/state_news/kansas-state-research-growing-frequency-of-dry-hot-and-windy-conditions-damage-wheat-yields/article_aca3be87-a1c7-5954-bec3-e22fda736d15.html

December 20, 2022, interviewed and news reported by Tim Carpenter in the Kansas Reflector.

<https://www.ksre.k-state.edu/news/stories/2022/12/agriculture-hot-dry-windy-impact-on-wheat.html>

December 20, 2022. Reported by Lawrence Times, Kansas. Kansas State research: Growing frequency of dry, hot and windy conditions damage wheat yields

<https://lawrencekstimes.com/2022/12/20/ksu-research-wheat-yields/>.

December 21, 2022, News reported by AGROINSURANCE.

<https://agroinsurance.com/en/News/USA---Growth-in-freque>

December 27, 2022, News reported by Dodge City Daily Globe.

Kansas State research: Frequency of dry, hot and windy conditions harming wheat yields.

<https://www.dodgeglobe.com/2022/12/27/kansas-state-research-frequency-of-dry-hot-and-windy-conditions-harming-wheat-yields/>

In addition to frequent interviews for radio, TV and newspapers on various weather and climate topics, we produce weekly audio clips on weather and climate phenomena. These are broadcast on a local radio station, are distributed to 75 other stations, and are accessible on the website (<http://www.ksre.ksu.edu/News/>). Another regular feature is participation in a weekly agricultural weather program which is broadcast statewide and covers current conditions and developing situations of interest to the agricultural community. Weekly and monthly climate updates are produced, as are special reports as needed which often focus on current events impacting Kansas. On the Kansas Mesonet website, we feature tools that monitor freeze conditions, hours below various thresholds, peak winds, evapotranspiration, soil moisture, soil temperature, animal comfort, inversion monitoring, and much more.

Research, Projects and Publications

Faculty and students associated with the Kansas Climate Office are involved in various applied research projects. The office is leading a climate modeling team to conduct dynamic downscaling climate information for southern areas of USDA ARS. The office was also supported by National Science Foundation to improve crop, soil, and climate data and integration for a climate-smart agricultural platform. Additionally climate change impact research continues to assess impacts of climate changes on crop yields, irrigation, and cropping system supported by Ogallala Aquifer Program (OAP) from USDA-ARS. In 2022, the office has published the following journal articles:

1. Wan, N., **X. Lin**, and R.A. Pielke Sr, 2022: Assessment of trends in an integrated climate metric—analysis of 200 mbar zonal wind for the period 1958–2021. *Theoretical and Applied Climatology*, 150:1217-1224.
2. Wan, N., X. Xiong, G. Kluitenberg, J.M. Hutchinson, R. Aiken, H. Zhao, and **X. Lin**, 2022: Estimation of biomass burning emission of NO₂ and CO from 2019–2020 Australia fires based on satellite observations. *Atmospheric Chemistry and Physics*, <https://doi.org/10.5194/acp-2022-447>.

3. Shi, D., Q. Huang, Z. Liu, T. Liu, Z. Su, S. Guo, F. Bai, S. Sun, **X. Lin**, T. Li, X. Yang, 2022: Radiation use efficiency and biomass production of maize under optimal growth conditions in Northeast China. *Science of The Total Environment*, 836 (2022): 155574.
4. Nozari, S., R.T. Bailey, E.MK Haacker, Z.T. Zambreski, Z. Xiang, and **X. Lin**, 2022: Employing machine learning to quantify long-term climatological and regulatory impacts on groundwater availability in intensively irrigated regions. *Journal of Hydrology*, 614 (2022):128511.
5. Fink, K.P., P. Grassini, A. Rocateli, L.M. Bastos, J. Kastens, L.P. Ryan, **X. Lin**, A. Patrignani, R.P. Lollato, 2022: Alfalfa water productivity and yield gaps in the U.S. central Great Plains. *Field Crops Research*, 289 (2022), 08729.
6. Zhao, H., L. Zhang, M.B. Kirkham, S.M. Welch, J.W. Nielsen-Gammon, G. Bai, J. Luo, D.A. Andresen, C.W. Rice, N. Wan, R.P. Lollato, D. Zheng, P.H. Gowda, **X. Lin**, 2022: US winter wheat yield loss attributed to compound hot-dry-windy events. *Nature Communications*, 13(1), pp.1-9.
7. Zuo, G., R. M. Aiken, N. Feng, D. Zheng, H. Zhao, T. J. Avenson, **X. Lin**, 2022: Fresh perspectives on an established technique: Pulsed Amplitude Modulation (PAM) chlorophyll a fluorescence. *Plant-Environment Interactions*, 3 (2), 41-59.

For our Climate office, we regularly publish agricultural station reports and extension articles. Faculty, staff, and students affiliated with the Kansas Climate Office presented research presentations at annual meetings of Kansas Emergency Management Association, Kansas Governor’s Water Conference, American Meteorological Society (AMS) meetings, and Annual Meetings of American Society of Agronomy (ASA). Our graduate students Nenghan Wan, Ruiyun Zeng, and Na Huang won three national awards at ASA meetings in 2022. Ongoing research is focused in several areas including Southern Great Plains wildfire outbreaks, inversions, soil moisture, current/historical data quality control and with a growing camera network for land use and real-time situational awareness.

Outreach and Education

Outreach activities include presenting at various workshops, and events including the Governor’s Water Conference, Regional Drought Conferences, Farm Profit Seminars, and historical society events. Directed training included presentations for spray applicator training, wildfire courses, and fire weather forecasting. Outreach to K-12 has included teacher workshops, participation in the STEM (Science Technology Engineering & Math) program and GROW (Girls Researching Our World) programs. In 2022, staff represented the Climate Office at the Water Matters Day at Sunset Zoo in Manhattan, and at the Science on Tap event, also in Manhattan.

Lastly, we continue to work closely with the offices of United States Representative Tracey Mann, United States Senator Jerry Moran, and Kansas State Representative Ken Rahjes. We provided them with weather/climate data, reports, and were able to provide related information to support our operation and provide them with scientifically sound data to make decisions. This also included briefings to the Governor’s Drought Mitigation Team and the Kansas Legislative Agriculture and Natural Resources Committee.

Kansas Mesonet and Climate Monitoring and Impact Assessment

As of December 31, 2022, the Kansas Mesonet consists of 80 stations. The vast majority of sites are 30-foot towers, but a few 10-foot tripods remain. These sites will be upgraded to full 30-foot towers in the future. Substantial growth is anticipated in 2023, the result of continued cooperation with the Homeland Security regions of Kansas to support both acts of terrorism and disaster mitigation utilizing weather data in the state.

Kansas Mesonet continues to support short term research that investigate water use and preservation of the Ogallala Aquifer (Kansas Water Office Water Technology Farms), resource and spray management tools (K-State Weed Science), inversion monitoring mechanisms (University of Missouri), blue green algae studies (University of Kansas), on farm research (Kansas Center for Agricultural Resources and the Environment), green roof – the growth of vegetation on campus roofs (K-State Department of Architecture) and long-term ecological studies (Wichita State University).

Data from the Mesonet and other networks within the state are distributed to numerous cooperators including the National Weather Service, the Drought Monitor, High Plains Regional Climate Center, Kansas Department of Emergency Management, United States Army Corps of Engineers, United States Forest Service and additional agencies.

2022 Kentucky Climate Center

ARSCO Report

State Climate Office:

Kentucky State Climate Office, Kentucky Climate Center

State Climatologist: Prof. Jerry Brotzge (gerald.brotzge@wku.edu)

Assistant State Climatologist: Assistant Prof. Zachary Suriano (zachary.suriano@wku.edu)

Staff/Service Climatologists:

Kentucky State Climate Office

Department of Earth, Environmental, and Atmospheric Sciences

Western Kentucky University

1906 College Heights Blvd., EST 340

Bowling Green, KY 42101

Phone: 270-745-4215

Website: www.kyclimate.org

Email: kyclimate@wku.edu

About the Kentucky State Climate Office:

The Kentucky Climate Center (KCC) is the state's official climate office, responsible for the collection, dissemination, and assessment of weather and climate information across the Commonwealth. Located at Western Kentucky University (WKU), the KCC leads research, educational, and outreach activities in collaboration with federal, state, and local governments; private sector firms; universities; and non-profit organizations. KCC partners include the American Association of State Climatologists (AASC); Kentucky Dept. of Public Health; Kentucky Dept. of Transportation; the National Weather Service; NOAA Midwest Regional Climate Center; the University of Kentucky; and the USDA among others. In its ongoing efforts to enhance local weather data collection, the KCC operates and maintains the Kentucky Mesonet, a network of 81 weather stations deployed in 71 counties across the state. Each station collects real-time, high-quality soil and atmospheric data, including air temperature, relative humidity, pressure, precipitation, wind speed and direction, solar radiation, and soil temperature and moisture. All data are collected, quality-controlled, archived, and disseminated to users in real-time, 24/7. These data support a variety of weather-sensitive industries and emergency management operations statewide.

The KCC also supports basic and applied research. Its Applied Climatology program engages in research in a wide variety of areas, including agriculture, emergency management, hydrology, public health, transportation, and wildfire. Its Climate Lab supports climate modeling, analyses and verification. The KCC internship program supports student research and engagement, providing students with hands-on experience in communication, data analysis, programming, statistics, visualization, and writing. Through these observational, research, and educational efforts, the KCC is working to help mitigate the negative impacts from high-impact weather and climate.

Both the State Climatologist and Assistant State Climatologist started at WKU in August 2022, replacing former State Climatologist Dr. Stu Foster, who retired in 2021, and Megan Schargorodski who left the State Climate Office effective January 6, 2023.

Communication Capabilities:

The KCC overhauled its website in fall of 2022 and released a new version in early 2023 - <https://kyclimate.org>. The KCC also operates and maintains a second website for the Kentucky Mesonet - <https://www.kymesonet.org/>. These websites are designed to better communicate data and products to interested parties. Special links are provided for Data Requests, which provides for a common, detailed form for data inquiries and ensures a prompt response. The KCC website provides for a common landing page to provide easy access to frequently requested federal and state climate products, as well as state-centric climatology information. Additional pages provide for specialized historical and climatological products. The KCC website remains under development with additional products to be added through summer 2024. The Mesonet website will undergo redevelopment during 2024.

The KCC also maintains a strong presence in social media on Facebook and Twitter with over 2,000 followers on Twitter and over 4,000 on Facebook: <https://www.facebook.com/kymesonet/> , <https://twitter.com/kymesonet> , <https://twitter.com/KYClimate>.

Information Services

The KCC maintains a variety of services for state partners and the general public. We provide real-time KY Mesonet data to the National Weather Service via the National Mesonet Program (NMP), and we provide real-time feeds to a number of media across the state. We also provide archived data to a variety of users upon request. We also work to maintain updated state climatologies, and these are made available through a variety of presentations, monthly webinars and websites. Monthly webinars can be accessed via our KCC YouTube Channel: <https://www.youtube.com/channel/UCDg3h8leOZa0wHap90rX5Rw>

Research, Projects and Publications

We operate a robust research program, with multiple faculty and scientists contributing. During 2022, we had several ongoing research projects. One such project is a NOAA-sponsored program funded through the US Forestry Service and USDA. Titled, “Advancing Forest Soil Moisture Monitoring in the Daniel Boone National Forest”, the grant is a novel program to learn how best to collect soil data from within the forest canopy. This project has funded the installation of two Kentucky Mesonet stations and 150 soil sensors. Data are collected and archived and shared with program partners. A second research program is planning regional sensor deployments for the April 2024 solar eclipse. The KCC is also working with the Indiana and North Carolina Climate Offices on ongoing/future research projects. The Climate Office also supports numerous student research opportunities; these research projects have included GIS-focused mapping, Mesonet climatologies, high-impact weather analyses and metadata generation. Peer-reviewed publications are listed on the climate office website: <https://www.kyclimate.org/research/publication>; additional online materials (such as event-focused historical summaries) can be found throughout the website and social media pages. Recent publications include:

Brotzge, J. A., and Coauthors, 2023: Challenges and Opportunities in Numerical Weather Prediction. *Bull. Amer. Meteor. Soc.*, **104**, E698–E705, <https://doi.org/10.1175/BAMS-D-22-0172.1>.

Rappin, E., R. Mahmood, U. Nair, and R. A. Pielke, Sr, 2022: Land–Atmosphere Interactions during GRAINEX: Planetary Boundary Layer: Evolution in the Presence of Irrigation. *J. Hydrometeorology*, **23**, 1401-1417. <https://doi.org/10.1175/JHM-D-21-0160.1>.

Phillips, C. E., U. Nair, R. Mahmood, E. Rappin, and R. A. Pielke, Sr, 2022: Influence of Irrigation on Diurnal Mesoscale Circulations: Results from GRAINEX. *Geophysical Research Letters*, e2021GL096822. <https://doi.org/10.1029/2021GL096822>

Outreach and Education

The Kentucky State Climate Office strongly supports regular outreach and educational activities. The KCC recently hired a new Director of Outreach & Education (Mr. Shane Holinde, a well-known local TV meteorologist), beginning March 15, 2023. Nevertheless, the KCC provided a number of community outreach presentations during 2022. In addition, numerous media interviews were done with television, radio and print media, with many focused on the December 2021 Western Kentucky tornadoes and July 2022 Eastern Kentucky flooding. A list of recent media can be found on our climate website homepage (lower left) - <https://www.kyclimate.org/>.

Monitoring and Impact Assessment

The Kentucky Climate Office maintains and supports the Kentucky Mesonet, a network of over 80 automated weather stations deployed across the state. The KCC employs ten full-time staff and several students to operate the network, which produces over one million observations annually. The KCC disseminates the data and products to a variety of public, private, and academic partners. In addition, the State Climatologist submitted a large MRI proposal to NSF in early 2023 to add additional above-ground observing capabilities to the network.

The KCC also maintains strong ties with the Midwest Regional Climate Office, sharing regional data with neighboring states. The Climate Office also partners with the University of Kentucky and Kentucky Division of Water to produce the weekly statewide drought update.

Louisiana Office of State Climatology

ARSCO Annual Report for 2022

State Climatologist: Barry Keim

Staff/Service Climatologists:

Derek Thompson, Research Associate and User Services Coordinator

Vincent Brown, Research Assistant Professor

Anna Sitzman, Graduate Student

Jordan Fazio, Graduate Student

Samantha Carmada, Graduate Student

Cameron Goff, Graduate Student

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About the Louisiana Office of State Climatology

The mission of the Louisiana Office of State Climatology (LOSC) and the Louisiana State Climatologist is to serve as the State focal point for activities pertaining to the climate of Louisiana. Responsibilities include:

- to collect, archive, and make available climate data for the state of Louisiana
- to provide climate education and information to the citizens of the region through various outreach programs including the media
- to maintain an active research program pertaining to the climate of Louisiana and the region.

To achieve these goals, the LOSC cooperates with LSU, the National Weather Service (NWS), Southern Regional Headquarters of the NWS, the Southern Regional Climate Center (SRCC), and the National Centers for Environmental Information (NCEI).

Communication Capabilities

The LOSC has a user-friendly website, and communicates via twitter, facebook, and telephone. The LOSC handles hundreds of data requests annually from the public, including researchers, lawyers, students, insurance adjusters, construction companies, local/state/federal offices, and more. In 2022 alone, the LOSC has had 24,970 Twitter Views, and 230,869 LOSC Website hits demonstrating an effectiveness in reaching the public through multiple means.

Information Services, Products and Tools

We provide daily, weekly, and monthly summaries of the State's climate through our website. The LOSC also provides a weekly summary of Louisiana Climate Data to the National Agricultural Statistics Service that is published weekly in the *Louisiana Crop Weather Summary*.

Research, Projects, and Publications

Publications:

Bolinger, R.A., V.M. Brown, H.E. Attard, A.M. Bentley, C.M. Fuhrman, K.L. Gleasen, T.A. Joyner, B.D. Keim, A. Lewis, J.W. Nielson-Gammon, C.J. Stiles, W. Tollefson, H.E. Attard, and A.M. Bentley. 2022. An Assessment of the Extremes and Impacts of the February 2021 South-Central U.S. Arctic Outbreak, and how Climate Services can Help. *Weather and Climate Extremes* 36:Article Number 100461.

Yin, L.R., L. Wang, B.D. Keim, K. Konsoer, W.F. Wang. 2022. Wavelet Analysis of Dam Injection and Discharge in Three Gorges Dam and Reservoir with Precipitation and River Discharge. *Water* 14(4):Article Number 567.

Invited Lectures:

“NOAA:Climate Change and It's Projected Impact in Louisiana.” Presented at the Louisiana Resilience Summit, Lafayette, Louisiana, November 16, 2022.

“Louisiana Climate Extremes.” Presented to the Petrochemicals Feedstocks Association of the Americas (PFAA), Lake Charles, Louisiana, October 27, 2022

“Hurricane Season 2022.” Presented to the Lion's Club of Baton Rouge, July 11, 2022.

“Coastal Hazards.” Presented at the SCIPP Climate Adaptation Summer Academy, Norman, Oklahoma, June 6, 2022.

“Hurricanes, Storm Surge, Heavy Rainfall, and Freezes in a Changing Climate” Presented at the Capital Regional Planning Commission annual meeting, Baton Rouge, June 8, 2022.

Grants:

Keim, B.D. (P.I), V.M. Brown, and A.B. Lewis. Southern Climate Impacts Planning Program (SCIPP) Phase IV. **Funded** by the National Oceanic and Atmospheric Administration-Coastal and Ocean Climate for \$1,586,105 from September 2021 to August 2026.

Keim, B.D. (P.I), V.M. Brown, A.B. Lewis, A. Haberlie, W. Shao. Planning a Flood Resilient Future for New Orleans, LA. **Funded** by the National Oceanic and Atmospheric Administration-Adaptation Sciences (AdSci) for \$300,000 from September 2021 to August 2023.

Keim, B.D., V.M. Brown, and A.B. Lewis. A roadmap for Developing Resilient Coastal Shellfish Populations: Using Spatial and Process-based Modelling for Restoration Under Current and Predicted Future Water Quality Conditions. . **Funded** by the U.S. Department of the Interior for \$299,338 from October 2021 to September 2023.

D'Elia, C. (P.I.), with K.L. DeLong, V.H. Rivera-Monroe, and B.D. Keim. A Proposal to Host the Department of Interior's South-Central Regional Climate Science Center. **Funded** by the U.S. Department of the Interior for \$642,032 from September 2019 to August 2024.

Outreach and Education

The LOSC provides a weekly summary of Louisiana Climate Data to the National Agricultural Statistics Service that is published weekly in the *Louisiana Crop Weather Summary*.

Provided 61 interviews to Louisiana Radio Network on Weather and Climate Topics relevant to the State.

Also provided interviews with WBRZ-TV (ABC) Baton Rouge, Newsweek, The Walls Project, WWL-Radio New Orleans (3x), National Geographic, Times Picayune, Advocate (Baton Rouge).

Monitoring and Impact Assessment

Serve on the U.S. Drought Monitor - Weekly Ad Hoc Advisory Committee.

Maine Climate Office

Annual Report for Calendar Year 2022

Dr. Sean D. Birkel, Maine State Climatologist
Ana Trueba (MS student; September 2022–present)

Climate Change Institute & Cooperative Extension

University of Maine

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<https://mco.umaine.edu/>

<https://climatechange.umaine.edu/climate-matters/maine-state-office/>

e-mail: birkel@maine.edu

About the Maine Climate Office

The Maine Climate Office (MCO) is based at the University of Maine in Orono and overseen by state climatologist Dr. Sean Birkel, who is an assistant professor with a joint appointment to the Climate Change Institute and Cooperative Extension. The role of the MCO is to 1) disseminate climate and weather information, data, and interpretation to Maine stakeholders and the general public; 2) consult and coordinate with federal and state agencies and other academic units in climate related activities; and 3) undertake climate research. The Climate Change Institute is one of the oldest climate research institutes in the United States, and from its beginning has emphasized interdisciplinary research of both the natural and human dimensions of climate. From this setting, the MCO can connect Maine stakeholders to an array of climate expertise over a range of timescales for disciplines including anthropology, atmospheric chemistry, climate modeling, ecology, environmental monitoring, glacial geology, glaciology, climate adaptation and sustainability, among others. Through Cooperative Extension, the MCO has additional means to connect with stakeholders in education, agriculture, and natural resources areas such as forestry.

Communication Capabilities, Products and Tools

The MCO has a website with data tools and resources, and most communications from stakeholders are made either by e-mail to the state climatologist, or by phone to the Climate Change Institute main office. Birkel posts seasonal climate summaries to Maine Climate News (<https://extension.umaine.edu/maineclimatenews/>), which is hosted by Cooperative Extension. He is also serving as coordinator for the Maine Climate and Agriculture Network (<https://umaine.edu/climate-ag/>).

Maine Climate Office (<https://mco.umaine.edu>) is a website that provides climate and weather information to Maine stakeholder in support the climate services mission. The climate data access pages and visualizations are primarily adapted from Climate Reanalyzer, but the Maine Climate Office site also includes daily-updated temperature and precipitation observations from over 40 locations across the state, NOAA seasonal climate outlooks, drought updates, and a publications

page with links to Maine climate reports. The Maine Climate Office is continually being updated to include more climate and weather resources relevant to Maine stakeholders.

Climate Reanalyzer (<https://climatereanalyzer.org>) is a data visualization platform for historical reanalysis, climate models, and global and regional weather forecasts. The site has a daily viewership of 2,000–3,000 users, and makes several terabytes of publically sourced climate information available through a variety of interactive content pages for both education and research audiences. Birkel has been developing Climate Reanalyzer since spring 2012, and site is integral to both research and the climate services provided as the state climatologist. Images from Climate Reanalyzer commonly appear in mainstream reporting (e.g., New York Times, Washington Post, CNN) and social media.

Birkel is currently working with colleagues at the University of Maine Cooperative Extension to provide agricultural stakeholders with customized 10-day hourly weather forecasts from NOAA/NWS with derived agriculture-specific variables. This service, called Ag Radar Weather, is free to Maine growers, and available to others for a nominal fee to cover operational costs.

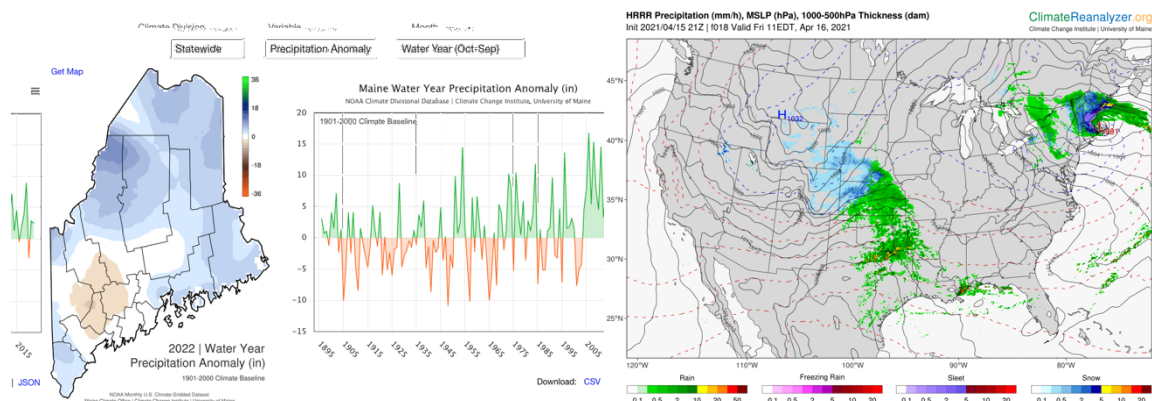


Figure 1. MCO time series/map interface for monthly, seasonal, and annual climate divisional data (left); and example Climate Reanalyzer/MCO weather forecast map from the HRRR model.

Information Services

- The MCO regularly receives and responds to data and climate related information requests. Birkel gives public talks, panel discussions, visits with school groups, and interviews with local news throughout the year.
- Birkel is serving on the Scientific and Technical Subcommittee (STS) of the Maine Climate Council (MCC), and was lead author of the climate section of the 2020 report *Scientific Assessment of Climate Change and Its Effects in Maine. A Report by the Scientific and Technical Subcommittee (STS) of the Maine Climate Council (MCC)*. The MCC is a state government initiative and encompasses “an assembly of scientists, industry leaders, bipartisan local and state officials, and engaged citizens working to address the effects of climate change” in Maine. In 2020, the MCC developed a 4-year climate action plan to guide the state in achieving CO2 neutrality by 2045 and drastic reductions in greenhouse gas emissions (45% below 1990 levels by 2030, and 80% below 1990 levels by 2050) as outlined in state law.

Research, Projects and Publications

Research at the MCO includes climate variability (Maine, North Atlantic, and elsewhere), climate modeling, and data visualization development. We are also producing climate analyses relevant to agriculture, such as growing degree-day and evapotranspiration maps from long period gridded datasets. Funded projects and recent publications related to the MCO include:

Current and Recent Funded Research

- NSF P2C2 1600018 (PI Mayewski, P.A.; co-PI **Birkel, S.D.**) [term 5/2023]. Collaborative Research: Ultra-High-Resolution Investigation of High Andean Snow and Ice Chemistry to Improve Paleoclimatic Reconstruction and Enhance Climate Prediction. *Activities*: Using reanalysis and dynamically downscaled meteorological fields to investigate Amazon moisture transport to High Andean ice caps.
- Russell Grinnell Memorial Trust (PIs **Birkel, S.D.** and Mayewski, P.A.) [term 5/2023], Revitalizing CCI's 10Green.org to Expand and Enhance Access to Air Quality Data in the Context of Health and Climate Change. *Activities*: This project will support the revitalization of the Climate Change Institute's air quality website, 10Green which enables users to score the relative air quality health of towns and cities in the U.S. based on data from the EPA. The website was first developed in 2010, and in this project the website design, usability, will be improved for modern web browsers. The data content will be expanded to include access to gridded air quality forecasts.

Publications (peer-reviewed)

1. Peltier, C., Kaplan, M.R., Sagredo, E.A., Moreno, P.I., Araos, J., **Birkel, S.D.**, Villa-Martinez, R., Schwartz, R., Reynhout, S.A., Schaefer, J.M. (2023). The last two glacial cycles in central Patagonia: A precise record from the Ñirehuao glacier lobe. *Quaternary Science Reviews* 304, 107873. <https://doi.org/10.1016/j.quascirev.2022.107873>
2. Calderwood, L., Koehler, G., **Birkel, S.D.**, Roche, E. (2022). Weather information and decision-support tool needs assessment. *Journal of Extension*. 60 (3), Article 1. <https://doi.org/10.34068/joe.60.03.01>
3. **Birkel, S.D.**, Mayewski, P.A., Perry, L.B., Seimon, A., Andrade-Flores, M. (2022). Evaluation of reanalysis temperature and precipitation for the Andean Altiplano and adjacent cordilleras. *AGU Earth and Space Science*, 9(3), e2021EA001934. <https://doi.org/10.1029/2021EA001934>
4. Simonson, J.M., **Birkel, S.D.**, Maasch, K.A., Mayewski, P.A., Lyon, B., Carleton, A.M. (2022). Association between Recent U.S. northeast precipitation trends and Greenland blocking. *International Journal of Climatology*, 1–12. <https://doi.org/10.1002/joc.7555>
5. Tasnim, R., **Birkel, S.D.**, Calderwood, L., Roberts, S., Zhang, Y. (2022). Seasonal Climate Trends across the Wild Blueberry Barrens of Maine, USA. *Atmosphere*. <https://doi.org/10.3390/atmos13050690>
6. Schattman, R.E., Zhang, Y-J., Smart, A., **Birkel, S.D.**, Jean, H., Barai, K. (2022). Strawberry growth under current and future rainfall scenarios. *Water*, 14(3), 313. <https://doi.org/10.3390/w14030313>

7. Amirbahman, A., Fitzgibbon, K.N., Norton, S.A., Bacon, L.C., **Birkel, S.D.** (2022). Controls on the epilimnetic phosphorus concentration in small temperate lakes. *Environmental Science: Processes & Impacts*, 24, 89. <https://doi.org/10.1039/d1em00353d>
8. Clifford, H.M., Potocki, M., Rodda, C., Dixon, D., **Birkel, S.D.**, Handley, M., Korotkikh, E., Introne, D., Schwanck, F., Tavares, and 15 others (2022). Prefacing unexplored archives from Central Andean surface-to-bedrock ice cores through a multifaceted investigation of regional firn and ice core glaciochemistry. *Journal of Glaciology* 1–15. <https://doi.org/10.1017/jog.2022.91>
9. Potocki, M. Dixon, D.A., Kurbatov, A.V., Casassa, G., Zamora, R., Handley, M.J., Introne, D., Grigholm, B., Korotkikh, E.V., **Birkel, S.D.**, Clifford, H., Mayewski, P.A. (2022). Trace metal emission history captured in a Chilean ice core. *Atmospheric Environment* 276, 119002. <https://doi.org/10.1016/j.atmosenv.2022.119002>
10. Potocki, M., Mayewski, P.A., Matthews, T., Perry, L.B., Schwikowski, M., Tait, A.M., Korotkikh, E., Clifford, H., Kang, S., Chogyal Sherpa, T., Kumar Singh, P.K., Koch, I., **Birkel, S.D.** (2022). Mt. Everest’s highest glacier is a sentinel for accelerating ice loss. *NPJ Climate and Atmospheric Science*, 5(7). <https://doi.org/10.1038/s41612-022-00230-0>

Book Chapter

1. Jacobson, G.L., **Birkel, S.D.**, Norton, S.A., Hall, B.L. (2022). Chapter 2: Climate and biodiversity in Maine. In A. Calhoun, *Our Maine: exploring Maine’s natural heritage*. Down East Books.

Outreach and Education

- In 2022, Birkel gave nine public talks or panel discussions, and gave at about 20 media interviews.
- Birkel is coordinator for the Maine Climate and Agriculture Network, an initiative to increase communication and coordination within the University of Maine community among faculty and students working on issues related to climate and agriculture.
- The Climate Reanalyzer website is used by ~2,500 people daily, and the Facebook page for the site has over 7,200 followers. Images from the site commonly appear in news and social media.

Monitoring and Impact Assessment

The MCO was involved in the publication of *Maine’s Climate Future 2020 Update* (Fernandez et al., 2020), which provides an overview of Maine’s recent historical, present, and future projected climate and impacts for a target audience of decision-makers and the general public. Birkel also contributed to climate impact assessment as co-author to the report *Scientific Assessment of Climate Change and Its Effects in Maine. A Report by the Scientific and Technical Subcommittee (STS) of the Maine Climate Council (MCC)*.

Maryland State Climatologist Office (MDSCO)

ARSCO Annual Report for 2022

State Climatologist: Alfredo Ruiz-Barradas

Assistant State Climatologist: None

Staff/Service Climatologists: None

Affiliation/Sponsor: University of Maryland College Park

Street Address: 4254 Stadium Dr., Atlantic Building # 3437 **City, State Zip code:** College Park, Maryland 20742-2425 **Telephone number:** 301- 405-0160

Fax number: 301- 314-9482

Website(s): <https://www2.atmos.umd.edu/~climate>

Social media: None

Email address(es): climate@umd.edu, aruizb@umd.edu



About the Maryland State Climate Office

The Office is in the Department of Atmospheric and Oceanic Science (AOSC) at the University of Maryland College Park. It has existed since the 1980s and even earlier when Helmut E. Landsberg helped create the Department of Meteorology –our predecessor – in the late 1960s. The Office already has a service history to the State by providing data services and consultation to public and private users. With the support of the Department’s Chair, the MDSCO has been undergoing a renewal since 2021. The Office has access to the Department’s computational and communication capabilities needed to advance the ARSCO requirements for a recognized Office: 1) monitoring and impact assessment, 2) research, 3) information services, and 4) outreach via awareness of weather and climate issues, education, and development of climate products.

Communication Capabilities

The communication capabilities of the MDSCO are rooted in the AOSC Department’s communication and computational capabilities. Computational resources include server-based computation, data storage, technical support, and infrastructure.

These machines provide numerous services, from web hosting to high-volume filesystem serving and CPU-intensive parallel processing. Many basic services are provided to faculty and students within the AOSC department, such as scanning, color printing, classroom projection, and audio systems. A great asset to the MDSCO is the acquisition of a data server named *ahkee* (after the Nanticoke word for Earth), which hosts two data disks of 18TB each, named *luwan* and *nipen* (after the Lenape words for winter and summer, respectively), honoring the Tribes who lived and are still present in Maryland; the server is at the core of our efforts to do research and provide relevant climate products for the state.

Reliable wired (1 Gbps) and wireless (~110 Mbps), fast internet connections are used to download data sets from NCEI every month and upload and disseminate monthly and seasonal climate bulletins. While telephone, fax, and mail services are available as vias of communication between the MDSCO and the public, e-mail has been the preferred way to contact the Office and to disseminate the Maryland Climate Bulletin. The distribution e-mail list of the Bulletin is always increasing; it reaches several groups within the university (e.g., ESSIC, AOSC, College of Agriculture and Natural Resources, Extension Offices, Maryland Climate-Smart Ag Project, other Campuses), state (e.g., Maryland Emergency Management, Maryland Department of the Environment, Maryland Commission on Climate Change), and federal (e.g., NOAA, USDA) institutions, and independent organizations (e.g., farmers, Maryland's Best, Environmental Law Institute).

The Office maintains its website, which is undergoing a series of changes to reflect the ARSCO requirements better.

Information Services, Products and Tools

Information services have been provided to newspapers, citizens, and state agencies as follows:
Service:

- Responding to an NPR reporter on issues in states without mesonets, 2/2022.
- Responding to a Capital News Service reporter on the science of Farmer's Almanacs, 12/2022.
- Guidance and data of wind profilers in the state, 7/2022.
- Feedback to the Maryland Department of Environment on a Probable Maximum Precipitation study for Maryland carried out by Applied Weather Associates, 12/2022.
- Analysis of extreme daily precipitation (≥ 2 in) in the state to help guide the site selection of the first phase of installation of the mesonet towers, 11/2022.
- Contribute to advancing the Maryland mesonet project by researching instruments and network density, reviewing the literature on best practices,
 - and elaborating on a brochure for local emergency management managers and landowners.

Products:

- Monthly Maryland Climate Bulletin.

Tools:

Improving the MDSCO website, which is still in progress.

Research, Projects and Publications

Research

- Analysis of extreme daily precipitation (≥ 2 in) in the state as represented in NCEI's nClimGrid-Daily data set.

Projects

- Redesign the website of the MDSCO
- Design relevant products to display in bulletins.
- Analysis of extreme daily precipitation (≥ 2 in) in the state to help guide the site selection of the first phase of the installation of mesonet towers.
- Advancing the Maryland mesonet project.

Publications

- Monthly Maryland Climate Bulletin, available at:
- <https://www2.atmos.umd.edu/~climate/Bulletin>

Outreach and Education

- Outreach and education via interviews and bulletins.

Monitoring and Impact Assessment

- Monitoring is done via the federal and state networks, including:
 - Climate: [present](#) and upcoming [month](#) and [season](#)
 - [Weather](#)
 - [Hydrology](#)
 - Flooding along the [coasts](#) and [rivers](#)
 - [Water Quality](#)
 - Air Quality: [particles](#), and [O3/SO2](#)
- Impact Assessment is limited to monitoring drought conditions at the moment.

Michigan State Climatological Resources Program

ARSCO Annual Report for 2022

State Climatologist: Jeff Andresen

Staff/Service Climatologists: Aaron Pollyea, Mike Kiefer, Keith Mason, and B.J. Baule

Dept. of Geography, Environment, and Spatial Sciences

Michigan State University

Street Address: 673 Auditorium Road

City, State Zip code: East Lansing, MI 48824

Telephone number: 517.432.4756

Fax number: 517.432.1076

Website: <http://climate.geo.msu.edu/>

Email: andresen@msu.edu

About the Michigan State Climate Office

The Michigan Climatological Resources Program (MCRP), home of the Office of the Michigan State Climatologist within MSU's Dept. of Geography Environment, and Spatial Sciences, is the archival and service center for climatological data and related information for Michigan.

Leadership of MCRP is the responsibility of the State Climatologist, who supervises operational and research activities under the direction of the Chair of the Geography Department. Operational and research support in the program are provided by Aaron Pollyea and Mike Kiefer. Additional technical support was provided by Keith Mason, the Program Manager of the Enviroweather system and William (B.J.) Baule, a Ph.D. Candidate who works with MCRP on occasion in association with his assigned duties with the Great Lakes Integrated Sciences and Assessment (GLISA) project of which MSU is a partner. MCRP receives the majority of its funding support from the Michigan AgBioResearch Program (formerly the Michigan Agricultural Experiment Station) and Michigan State University Extension (MSUE).

Communication Capabilities

The majority of public requests for climate data and information are placed via telephone and email exchanges. While the majority of requests are still filled through conventional mail service, a growing proportion are filled through email. MCRP also provides information through dedicated worldwide web sites (see below). Climate data are collected operationally in the program via internet (Unidata's Internet Data Distribution system) and dedicated satellite receiver connections, and via internet and telephone through the program's Enviroweather information access system.

Information Services, Products and Tools

The total number of formal billable requests for climate information in 2022 was 53, well below the five-year average of 53. Most of the requests were received via phone or email. The majority of the requests were from law firms, the insurance industry, and other researchers. The average amount of payment received per billable request was \$76.01 which was up slightly from \$75.24 in 2021. The decline in formal billable requests is consistent with a long-term downward trend, linked at least partially to the availability (and accessibility) of detailed climate data from a number of providers including the National Centers for Environmental Information.

Research, Projects and Publications

MCRP maintains an active research program addressing climate-related issues in the state and region. Current projects involve investigation of past and projected future climate changes in the region and potential impacts of weather and climate on regional agriculture. We also continued work on the Enviroweather project, the primary objective of which is the development and implementation of www-based techniques and tools that address weather- and climate-related processes in agricultural and natural resource management in Michigan. During 2022, staff at MCRP authored or co-authored 3 refereed articles and 2 non-refereed articles and technical reports and provided 4 academic conference presentations, lectures, and seminars. MCRP was associated with 3 new external grants totaling \$236,968, 9 grants in force from previous years, and 5 new grant proposals submitted.

Outreach and Education

The MCRP in conjunction with MSUE (through the SC's formal appointment) also maintains an active outreach program through traditional venues, providing climate-related information in formats ranging from public speaking engagements to regular columns in the popular press. During 2022, the MCRP staff provided 9 ad hoc interviews to print, radio, and television media (including 5 TV/radio appearances) and 25 public lectures or seminars. The SC provided regularly scheduled weekly and bi-weekly weather/climate webinar-based updates with MSU Extension (73 total). The SC and some MCRP staff also write weather- and climate-related columns on a daily (MSUE Crop Advisory Team, see <http://msue.anr.msu.edu/news/>) and bimonthly (Michigan Farm Bureau) basis. During 2020, 22 columns were written. MCRP also continues to serve as state-level coordinator of Michigan's Community Collaborative Rain, Hail, and Snow (CoCoRaHS) network.

Monitoring and Impact Assessment

One of the major operational activities of MRCRP is the Enviroweather Project. The overarching mission of the Enviroweather Project is the provision of relevant, dependable, and sustainable weather and climate information to support Michigan's agriculture and natural resource industries. The major elements and functions of the Enviroweather system are environmental monitoring through a 101 site mesonet network of automated weather stations, model application, and integrated delivery of products and education in their usage. Given its mission, Enviroweather maintains an active research program focusing on the development and application of weather- and climate-related information. Enviroweather also supports the research efforts of other scientists and projects requiring detailed environmental data and information. The system's automated weather mesonet network (formerly the Michigan Automated Weather Network) has grown considerably from 6 sites at its formation in 1997 to 101 sites in 2022. Geographical coverage of the network has also grown to additional areas of the state and to nearby sections of eastern Wisconsin (collaboratively with the University of Wisconsin). Enviroweather stations are designed with a variety of sensors required for diverse applications in agriculture and natural resources and include: air temperature and relative humidity (5-foot level), rainfall, wind speed and direction (10-foot level), solar radiation, soil temperature (at 2" and 4" depths), volumetric soil moisture (at 0-12" and 12"-24" levels), and leaf wetness (at a 39" high reference location and in a specified crop canopy). Additional vertical air temperature and wind data are available at two sites (Sparta and Williamsburg) with 20m towers to assist fruit and vegetable growers with frost protection.

Observations at each station are taken automatically every 3-60 seconds (depending on sensor) and downloaded to a central computer via cellular-IP phone telemetry for dissemination to the public at enviroweather.msu.edu. Data are updated on a real-time basis throughout the growing season at 30-minute intervals and every 3 hours November through February. Data quality control procedures include automated data scans, visual data inspection by a project team member, and regularly scheduled preventative maintenance site visits. Raw station data can be accessed at: www.agweather.geo.msu.edu/mawn. The number of weather-driven products and applications available on the Enviroweather site has increased from 19 in 2007 to more than 60 today. The products are generally organized by commodity type and function and range from forecasts of insect phenological stage to estimated potential evapotranspiration to tabular comparisons of recent past weather conditions with previous years.

During the past year, the Enviroweather system web page underwent a major modernization and rebuild, primarily to better serve users with smart phones or tablets. Page views during 2022 totaled 117,000 from 18,000 individual users, an average of 321 per day, although system usage was relatively greater during the spring and summer seasons. Continuing a long-term trend, the most heavily accessed products continue to be basic weather tables, statistics, historical comparisons, and summaries with over 76% of the total user page views (versus more sophisticated interactive and diagnostic models (eg IPM)). During 2022, 49.1% of users accessed the system by desktop computer, 47.5% by smart phone, and 3.3% by tablet.

Minnesota State Climate Office

ARSCO Annual Report for 2022

State Climatologist: Luigi Romolo PhD

Assistant State Climatologist: Peter Boulay

Staff/Service Climatologists: Kenny Blumenfeld PhD, Senior Climatologist

Affiliation/sponsor: Minnesota Department of Natural Resources
439 Borlaug Hall, University of Minnesota
1991 Upper Buford Circle
St. Paul, MN 55108-6028
phone: 651-296-4214 fax: 612-625-2208

Websites:

<https://climateapps.dnr.state.mn.us/index.htm>

<https://www.dnr.state.mn.us/climate/index.html>

Social media: <https://www.facebook.com/MinnesotaStateClimatologyOffice>

Email address(es) (individual and/or organizational)

Organizational: climate.dnr@state.mn.us

Individuals:

Luigi Romolo : luigi.romolo@state.mn.us

Pete Boulay: peter.boulay@state.mn.us

Kenny Blumenfeld: Kenneth.blumenfeld@state.mn.us

About the Minnesota State Climate Office

The Minnesota State Climatology Office (MN_SCO) exists to manage, analyze, and disseminate climate information in service to the citizens of Minnesota. The MN_SCO is funded by the State of Minnesota Department of Natural Resources - Division of Ecological and Water Resources, and housed at the University of Minnesota - Department of Soil, Water, and Climate. This partnership was formed in 1973.

The MN_SCO assists its customers in their investigations of the climate's impact on various components of the natural environment, and on socioeconomic activities. The MN_SCO uses its climate monitoring resources to quantify weather conditions and to place these conditions within historical and geographical context. The MN_SCO also provides quantitative summaries of historical climate conditions, allowing users to make informed decisions about future activities.

In order to provide its services, the MN_SCO requires an extensive historical climate data set. The database features data collected by Minnesota's high spatial density precipitation monitoring program, formed in the early 1970s. This "network of networks" utilizes the efforts of water-oriented state and local agencies to assemble precipitation data from approximately 1500 observers each year. Additionally, the National Weather Service (formerly the U.S. Weather Bureau) has maintained a large scale, volunteer-based climate monitoring network in Minnesota since 1890. Other, smaller scale climate monitoring efforts extend the historical record earlier into the 19th century. The MN_SCO also archives multi-element hourly weather data gathered at Minnesota's airports.

The MN_SCO provides customers with free access to a comprehensive electronic climate database. The MN_SCO also serves its customers by offering a variety of value-added analyses of climate data in the form of narratives, maps, graphs, and tables. Customers access MN_SCO products and services via a Web site, email, telephone, office visits, meetings, and public appearances.

The customers of the MN_SCO are many and varied. Customers can be grouped in the following categories:

- Minnesota Department of Natural Resources (sponsoring agency)
- State, Federal, and Local Governmental Agencies
- Private Sector Professionals (including the media)
- Academic Community
- General Public

Office Staff:

Luigi Romolo:	State Climatologist
Kenneth Blumenfeld:	Senior Climatologist
Peter Boulay:	Assistant State Climatologist
Greg Spoden:	Volunteer and former state climatologist
Brianna Wilde	Student Worker (2023)
Robert Bergstrom	Student Worker (2023)
Jeff Peters	Volunteer
Ben Boulay	Volunteer

Communication Capabilities

- Full-feature Web Page
- New Web page near finalization
- Facebook page
- Fully staffed information line
- Near-immediate response to email and media inquiries

Information Services, Products and Tools

- Web site – the MN_SCO Web site hosts approximately 3000 users per day. The Web site offers free access to nearly all of Minnesota’s digitized climate data, as well as a number of value-added products such as narratives, maps, and tabular summaries.
- The Web site offers on-line daily data entry and data maintenance capability to volunteer precipitation observers. These near real-time data are automatically transferred to the National Weather Service North Central River Forecast Center.
- The SCO has maintained its diverse suite of value added climate products. Many products are currently being updated to more modern architecture.
- Phone and email – the MN_SCO answers dozens of phone calls and emails per week from customers with climate questions.
- The SCO served over 200 media requests this past year.
- We now have over 5000 followers on Facebook.

Research, Projects and Publications

- Each year the MN_SCO is called upon to provide data sets and counsel to numerous researchers investigating topics involving atmospheric science.
- The MN_SCO participates in three advisory committees tasked to provide guidance concerning climate change adaptation research and outreach.

Outreach and Education

- Staff give frequent interviews to electronic and print media. This past year, our office has had over 200 media contacts.
- Staff are commonly requested to attend multi-agency, multi-disciplinary meetings where a climatological perspective is required.
- Staff make public appearances addressing matters of weather and climate. Our office gave roughly 85+ presentations this past year.
- Staff make climate science outreach efforts.

Monitoring and Impact Assessment

- The MN_SCO works with the National Weather Service to coordinate Minnesota's role in the *CoCoRaHS* program. The Minnesota State Climate Office has won the March Madness CoCoRaHS cup four years in a row. We also set the record for most signups.
- Web site offers a variety of routinely prepared summaries of weekly and monthly temperature, degree day, precipitation, and snow depth data.
- Web site offers a chronological journal of significant weather events, providing a description of the event, impacts, and historical context.
- This year the MN_SCO added or modified their value-added data products that utilize ACIS web services.
- The MN_SCO utilizes a list server to deliver a monthly electronic newsletter summarizing climate conditions observed during the previous month and the resulting impact on water resources.
- The MN_SCO is in frequent communication with authors of the U.S. Drought Monitor to ensure accurate drought depiction in Minnesota.
- Development and maintenance of a mesonet to support agriculture and long term climate monitoring. We recently upgraded 22 of our 41 mesonet stations by replacing the original all-in-one sensors with standard anemometers, Temperature/Relative Humidity sensors, and barometers. The remaining stations are scheduled to be upgraded this year.
- The MN_SCO are continuing work related to updating the State Drought Plan for Minnesota. This will be a collaborative effort amongst the various divisions of the Minnesota Department of Natural Resources and other relevant State agencies.

Mississippi State Climate Office

ARSCO Annual Report for the year 202

State Climatologist: Michael Brown, PhD

Staff/Service Climatologists: Caroline Sleeper (MSU Service Assistant)

Mississippi State University PO Box
5448

Mississippi State, MS 39762

662.325.3915

<http://www.geosciences.msstate.edu/state-climatologist/>

<https://twitter.com/MSClimateologist>

<https://www.facebook.com/MississippiClimateOffice/> mike.brown@msstate.edu

About the Mississippi State Climate Office

The Mississippi Office is a small office (with no real physical space) with university support for a service assistant. As a result the majority of data requests and data analysis are left to the two professors within the office. Through the use of the service assistant the office has developed a social media presence and a better web presence.

Communication Capabilities

We try to reach our potential customers through our social media and web presence. We still take data and analysis requests using email and phone.

Information Services, Products and Tools

We provide climate summaries through our various social media platforms. We also provide Drought Impacts from our developed app for MS to the Drought Monitor. In 2018 we began providing climate summary graphs for 10 locations across the state to public and government stakeholders.

Research, Projects and Publications

Ongoing

This past year the SCO has begun to revamp the DRI (Drought Reporting and Information) app to better represent wetness. The SCO will conduct meeting with the Alabama extension for the probability of joint work.

Publications

McCormick, A., A. Mercer, **C. Fuhrmann, and M. Brown**, 2022: Diagnosing the relationship between the Madden-Julian Oscillation and United States tornado outbreaks. *Mon. Wea. Rev.*, in review.

Outreach and Education

The SCO provided presentations to many civic organizations (scouts, rotary, seed producers, etc...) throughout the past year.

The SC is one of the co-state coordinators for the CoCoRaHS program in Mississippi.

The SC is a member of the MSU Crisis Action Team and coordinates with MEMA during episodes of threatening weather. Additionally, the SC is responsible for monitoring athletic events at colleges and universities across the state..

Monitoring and Impact Assessment

This past year the SCO has continued working on the update of the MSU All Hazards Mitigation Plan. The SC has also delivered video lectures to other colleges and universities in order to help them develop or modify their mitigation documents.

Missouri Climate Center

MISSOURI CLIMATE CENTER

ARSCO Annual Report for 2022

Dr. Patrick Guinan, Extension/State Climatologist
Mr. John Travlos, staff assistant
Mr. Jon Bongard, undergraduate assistant

University of Missouri 320 ABNR

Columbia, MO 65211

Ph: 573-882-5908

Missouri Climate Center: climate.missouri.edu Missouri Mesonet: mesonet.missouri.edu

Email: guinanp@missouri.edu



- facebook.com/missouriclimatocenter/
- twitter.com/ClimateMissouri
- youtube.com/channel/UCegoISxsG09fh3goOTaXUOg

The Missouri Climate Center is designated by the AASC as the official state climate office for Missouri and is a resource for weather and climate information. The State Climatologist collects and maintains an extensive historical climate database of Missouri weather records for monitoring and dissemination to the citizens of the state and beyond. This includes performing and assisting in the primary functions of the center whose mission is to advance the use of climate information for the economic and environmental benefit of Missouri and the public safety of its citizens through climate monitoring, research, education, and extension and information services. In 2022 we fulfilled hundreds of climate data requests including over 100 presentations, in-person and virtual. The following information provides information over the past year of how the Missouri Climate Center addressed each of its ARSCO qualifications.

Communication Capabilities:

- The MCC web site provides easy access to weather and climate information including links to specialized web sites for real-time and historical weather in Missouri. The Missouri Climate Center posts timely monthly weather and climate impact reports for the state of Missouri;
- Over 4000 lines of data arrays are collected daily from a network of 40 automated weather stations associated with the [Missouri Mesonet](http://mesonet.missouri.edu). The daily and hourly arrays are posted on a server for free unlimited access;
- 36 Missouri Mesonet stations provide 5-minute near real-time conditions;

- Continued development and recruitment for an e-mail delivery agricultural weather product called Horizon Point. Horizon Point is a custom weather analysis system for farmers and provides an opportunity to have specific weather reports sent directly to their e-mail address. Over 1,000 Missouri clients are enrolled;
- Mobile links with forecasts continue to be provided for all the real-time web sites.
- Missouri Climate Center Social Media Platforms: Facebook, Twitter and YouTube. Two social media specialists were hired in 2021 to develop and maintain Facebook, Twitter and YouTube social media accounts for the Missouri Climate Center. As of early 2023, the following metrics were achieved: MCC Facebook, 223 followers; MCC Twitter, 303 followers; MCC YouTube 31 subscribers, 19 videos, 3,033 views.

Information Services, Products and Tools:

- Submitted 2 press releases in 2022 to the Extension news service related to weather, climate and environment;
- Serve as an information source for the media including national, state, and local mediums;
- Fulfilled over 100 of requests for climate information and provided climatological expertise to numerous individuals, groups and agencies;
- Submit soil temperature information published in a national bulletin *Weekly Weather and Crop Bulletin*:
<https://www.usda.gov/sites/default/files/documents/wwcb.pdf>;
- Submit soil temperature data to the Midwestern Regional Climate Center for generating daily and weekly 2” and 4” soil temperature maps:
<https://mrcc.purdue.edu/RMP/currentMaps.html#banner>;
- Submit daily air temperature, soil temperature and solar radiation data to the Midwestern Regional Climate Center for assimilation into their cli-MATE system & ACIS;
- Run the rice model program to predict rice growth stages:
agebb.missouri.edu/weather/reports/ricedds.asp;
- Provide a weekly climate summary table for the *Integrated Pest and Crop Management*

Newsletter: <http://agebb.missouri.edu/weather/reports/gddTable.asp>;

- Provide a 2-inch and 6-inch soil temperature table as a Missouri Mesonet product:
agebb.missouri.edu/weather/reports/soilTemp2.asp;
agebb.missouri.edu/weather/reports/soysoil6.asp;
- Campus weather station and forecast linked to the MU College of Agriculture web site: <https://cafnr.missouri.edu/weather/>;
- The real-time mesonet stations are providing 5-minute weather conditions to the Meteorological Assimilation Data Ingest System (MADIS);
https://mesowest.utah.edu/cgi-bin/droman/stn_mnet.cgi?mnet=156
- Installed real-time automated weather station at New Madrid, MO:
<http://agebb.missouri.edu/weather/realtime/newmadrid.asp>;
- Installed real-time automated weather station at Sikeston, MO:
<http://agebb.missouri.edu/weather/realtime/sikeston.asp>;
- Installed real-time automated weather station at Springfield, MO:
<http://agebb.missouri.edu/weather/realtime/springfield.asp>;

- County Precipitation Departure Maps are provided for Missouri using PRISM data: <http://agebb.missouri.edu/drought/accurain.htm>;
- Design Storm Alert System tool captured extreme events in 2022: <http://agebb.missouri.edu/weather/designstorm/>;
- Missouri Frost/Freeze Guide widely used: <https://ipm.missouri.edu/frostfreezeguide/>;
- The Missouri Mesonet plays a critical role in the Crop Water Use App, which has nearly 800 active farm fields participating in Missouri: <http://ag3.agebb.missouri.edu/horizonpoint/cropwater/>;
- Missouri Mesonet real-time maps added four real-time weather stations to the site in 2022: New Madrid, Sikeston, Cardwell and Springfield: <http://mesonet.missouri.edu>

Research, Projects, and Publications:

The Missouri Mesonet has provided opportunities for educational programs, teaching, research, innovation, discovery and service to communities. It has led to the development of state-of-the-art information delivery systems, including transitioning 36 weather stations to wireless telecommunication and real-time weather data dissemination for local, state, and national outlets as well as public, private and federal entities. In 2022, the Missouri Mesonet real-time web pages received over 33,000,000 visits.

- Providing real-time weather status to 36 weather stations in the Missouri Mesonet;
- Provide climate data for graduate students and faculty research projects;
- In 2019, the Missouri Climate Center received a 2-year NRCS environmental quality incentives program grant to enhance and develop climate tools for Missouri including the enhancement of our Design Storm Alert System tool and developing [multi-sourced soil temperature/soil moisture maps](#) for Missouri;

Outreach and Education:

- I had numerous opportunities in 2022 to educate, consult, contribute, and provide technical assistance to Missourians and others. For example, in 2022, I participated in over 100 agronomy and horticulture virtual meetings with extension state specialists and regional extension specialists, including specialized town hall meetings for the public targeting producers and others interested in forages, livestock, row crops and row crops. These meetings provided relevant discussions and impacts related to pests, crops, diseases, forages, weather etc. and other current issues related to horticultural plants, crops and livestock.
- Gave virtual and in-person climate related presentations at state and national level;
- State Co-Coordinator of the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) in Missouri;
- Member of the State Drought Assessment Committee;
- Information resource for media outlets including Missouri Net, Brownfield Network, CAFNR Communications, and local TV, radio, and newspaper outlets.
- The Missouri Climate Center has been a NWS Cooperative weather observer for the weather station located at Sanborn Field, on the University of Missouri campus, since February 14, 1997. The MCC received its 25-yr award recognition in 2022, Figure 1.

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Figure 1.

Monitoring and Impact Assessment

[Design Storm Alert System](#)

In 2022, the Design Storm Alert System tool (DSAS) identified 6 extreme rainfall watch or alert events as they relate to the 25-yr/24-hr design storm event, which impacted 14 Missouri counties. The DSAS tool created an efficient automated system to track precipitation accumulations across the state notifying the Missouri Climate Center, Missouri Department of Natural Resources, farmers and other designated entities when and where precipitation totals indicate wet weather management may be warranted. The tool provides an automated approach to directly address concentrated animal feeding operation requirements. Impacts from the tool are relevant and timely, and assist stakeholders and decision makers with information that can be used for disaster mitigation, environmental compliance and nutrient management planning. Economic impacts include using a tool that reduces compliance costs and fines, and increase the value of better management. Additionally, unpermitted facilities that use the tool are less likely to have discharges leading to expenses associated with regulatory oversight.

[State Drought Assessment Committee](#)

Governor Parson activated the state drought assessment committee in the summer of 2022 and we met weekly to discuss information about drought conditions, drought

resources and the drought response plan which can be found at dnr.mo.gov/drought including agendas and further information about the Drought Assessment Committee.

Missouri Drought Monitor Assessment Team

A very important component of the State Climatologist/Missouri Climate Center program is participating in weekly national drought coordination related to the [U.S. Drought Monitor](#). The state climatologist has been participating in the Drought Monitor impact/information process in Missouri for nearly 20 years.

Every Monday, the state climatologist (SC) sends an email to individuals associated with four National Weather Service forecast offices in Missouri and the Missouri Department of Natural Resources. The SC requests their input and expertise for assessing conditions around the state. The team eventually comes to a consensus of recommendations for Missouri and the SC sends an email with recommendations and rationale, usually by late Tuesday afternoon, to the Drought Monitor (DM) author as well as a national DM list server of more than 400 participants.

The DM author considers our suggestions which are only one of many considerations that goes into the development of the DM map. The DM author considers several objective and subjective indicators and takes a “convergence of evidence” approach when it comes to producing the final DM map.

Providing local expertise is an extremely important component of drought assessment for Missouri. The U.S. Drought Monitor is used by state and federal agencies in identifying counties that may be eligible for various programs. Many federal programs and Missouri state agencies know the value and importance of the U.S. Drought Monitor and getting it right when it comes to assessing drought categories in Missouri.

Nearly every year, the Missouri Climate Center submits a [news release](#) encouraging Missourians to participate in the drought impact process. Nobody knows a drought and its impacts better than a person living in the affected area.

Nebraska State Climate Office

ARSCO Annual Report for 2022

State Climatologist: Dr. Martha E. Durr

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p) 402-472-5206
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Websites: <https://nsco.unl.edu>, <https://mesonet.unl.edu>

Social media: Twitter, @NebraskaMesonet

e) nsco@unl.edu, mdurr9@unl.edu



About the Nebraska State Climate Office

The Nebraska State Climate Office is housed in the School of Natural Resources at the University of Nebraska – Lincoln. Personnel include the Director and State Climatologist, an Agricultural Extension Climatologist, the Nebraska Mesonet Manager, Mesonet Technician / GIS Specialist, Research Ecologist, Mesonet Laboratory Manager, one Ph.D. student and two M.S. students. The NSCO manages and maintains a statewide weather network, the Nebraska Mesonet, which has 56 data-gathering stations across the state. The focus of our office is on monitoring, climate services, and stakeholder engagement.

Communication Capabilities

Communication and engagement processes with the NSCO include our web interface, social media accounts, provision of invited presentations, virtual and in-person interviews as requested, a weekly weather outlook provided to Market Journal television and KRVN regional radio, participation in working group sessions for decision support and briefing the state’s climate assessment committee. Data requests are filled through various means, determined by needs and requirements of the end-user. The office updates University of Nebraska Extension personnel on pertinent agricultural weather and climate conditions through bi-weekly phone calls from March through October. Community users are regularly engaged via telephone, email and walk-ins. The office has an active Twitter account with regular tweets on weather and climate topics. A monthly summary is developed that summarizes the most recent conditions for the previous month, including impacts and a climate outlook.

Information Services, Products and Tools

Approximately 400-500 data requests are serviced per year, with a third of them media oriented, 25 percent university affiliated research requests, and 10 percent are presentation requests. The approximately 30 percent remaining is spread fairly equally between agricultural interests, federal government requests, for-profit businesses, and state government. The NSCO completes 90% of data requests within 48 hours, with the exception for large data requests, detailed data analysis projects and lack of current information from federal data providers. Examples of projects worked

on during 2021 include climate projections for municipalities for peak water use consideration, impacts of the 2019 flood, tribal engagement activities across Nebraska and La Niña teleconnections for agricultural risk assessment. The NSCO maintains a website that is regularly updated with current and emerging weather and climate issues. This is done through a weekly weather update, a monthly climate summary, and access to Nebraska Mesonet data and information.

Research, Projects and Publications

The NSCO's ongoing areas of interest include meteorology, climatology and data gathering; data interpretation; assessment of current conditions and data for the agriculture community; and outreach services. The office also collaborates with a number of outside organizations, including the High Plains Regional Climate Center, UNL Extension, the Climate Assessment and Response Committee, USDA Northern Plains Regional Climate Hub and the National Drought Mitigation Center.

NSCO researchers have teamed with Nebraska Indian Community College and Platte Basin Timelapse Project to document and understand implications of the 2019 flood develop storytelling outcomes to blend indigenous and western science.

NSCO is leading an effort to revise a State Climate Report published by the University of Nebraska – Lincoln in 2014. A team of authors from Universities and tribal agencies across Nebraska are working in a collaborative effort. The revision stems from state legislative action taken in the 2022 session.

Peer-reviewed publications include:

Frankson, R., Kunkel, K. E., Easterling, D. R., Lin, X., Durr, M., Umphlett, N. A., Stiles, C. J. (2022). Kansas State Climate Summary 2022. (pp. 5). NOAA Technical Report NESDIS 150-NE. **Status:** Published

Frankson, R., Kunkel, K. E., Stevens, L. E., Durr, M., Umphlett, N. A., Stiles, C. J. (2022). Nebraska State Climate Summary 2022. (pp. 5). NOAA Technical Report NESDIS 150-NE. **Status:** Published

Frankson, R., Kunkel, K. E., Easterling, D. R., Durr, M., Akyuz, A., Umphlett, N. A., Stiles, C. J. (2022). North Dakota State Climate Summary 2022. (pp. 5). NOAA Technical Report NESDIS 150-NE. **Status:** Published

Outreach and Education

Risk assessments are provided for upcoming growing seasons for the agricultural community through media interviews, conference/meeting presentations, NOAA regional assessments, Climate Assessment and Response Committee input and the NSCO website.

In the past, agricultural weather assessments during the cropping season were made through published CropWatch articles. These outlooks were moved to the NSCO web-site and were provided weekly from June through early November, then bi-monthly through the following March. The weekly assessments looking at the latest National Agricultural Statistics Service statistics, summarize climate patterns the previous week, and assess the latest outlooks for the next 4 weeks. Bi-monthly reports include a monthly outlook at the beginning of each month and multi-season outlooks for the next year based upon the latest ENSO outlooks issued by the Climate Prediction Center.

The NSCO includes special event and detailed seasonal outlook analysis on our website. The seasonal outlook analysis (spring, summer, fall, winter) coincide with the NOAA CPC 3-month rolling outlook and is tailored based upon conditions observed across North America and how they may impact the outlooks going forward. NSCO's engagement with stakeholders remains broad and is systematically documented monthly. For provision of data and information within base climate services, the office regularly interacts with media, education and the agriculture sector. Nebraska Extension represents one of the primary customers. Agricultural groups include certified crop consultants, seed companies, insurance and lenders, local and state agriculture agencies. Regular interaction with the local National Weather Service offices occurs through drought assessment calls as well as Mesonet data delivery. Other constituents include the Nebraska Forest Service, Nebraska Natural Resource Districts, the Nebraska Department of Natural Resources, Public Power and Irrigation Districts, municipalities and private engineering firms. These engagements are primarily through service projects, presentations and provision Mesonet data products and regular assessments of current and emerging issues. Our office delivered 79 invited presentations to 2,526 individuals during 2022.

Monitoring and Impact Assessment

The NSCO maintains and operates the Nebraska Mesonet – one of the first such state networks in the U.S. The network consists of 56 stations providing real-time information to a variety of end users. The Mesonet has been a member of the National Mesonet Program since 2017 and is funded by 24 unique entities. Utility varies widely but is primarily in the sectors of weather forecasting, ground and surface water management, on-farm management, rangeland management, crop growth and disease assessment, emergency management, wildfire danger, drought and flood risk, public health and research applications. Mesonet data are used extensively by the NSCO and delivered in real-time to NOAA.

All sensor calibrations are performed in-house. For the 2022 season, we again offer calibration services to other Mesonet operations. Currently, we offer calibration and light maintenance for temperature/humidity probes, barometers, wind monitors and solar radiation sensors.

The University of Nebraska and Nebraska Mesonet has entered an agreement with the U.S. Army Corps of Engineers for the Upper Missouri River Basin Snowpack and Soil Moisture Monitoring Program. Through the next five years, a total of 35 weather stations will be installed in Nebraska within the Upper Basin.

Nevada State Climate Office

ARSCO Annual Report for 2022

State Climatologist: Steph McAfee

Assistant State Climatologist:

Staff/Service Climatologists:



Student Employees: 2 undergraduate workers and 1 graduate student

Affiliation/sponsor University of Nevada, Reno

Street Address 1664 N Virginia St.

City, State Zip code Reno, NV 89558

Telephone number 775-784-6999

Fax number 775-784-1058

Website(s) <https://extension.unr.edu/climate>, <https://livingwithdrought.com>

Social media N/A

Email address(es) climate at unr.edu, smcafee at unr.edu

About the Nevada State Climate Office

The Nevada State Climate Office provides timely, accurate, and relevant information and education about weather and climate and their impacts for everyone who lives, works, or recreates in Nevada. The NSCO provides access to information, conducts research, and engages with people throughout the state.

Communication Capabilities

The Nevada State Climate Office (NSCO) maintains a website associated with the University of Nevada, Reno Extension. Although the State Climatologist did not have an Extension appointment in 2022, Extension agreed to keep the website live. In spring of 2022, the NSCO also took over temporary management of Extension's Living with Drought program and its website at <https://livingwithdrought.com/>. It now seems likely that Living with Drought will reside permanently with the State Climate Office. The Living with Drought website is well regraded and had nearly 3900 users in 2022.

Information Services, Products and Tools

Owing the severity of the drought across Nevada, the state climate office produced 12 monthly drought reports and a well-received water-year review, as well as its mandated quarterly climate reports. This year, we advertised opportunities for public comment on the National Climate Assessment report; did a simple assessment of how much precipitation it would take to get out of drought (it was a lot and yet most of the state is now out of drought); presented a quick analysis of summer monsoon forecast skill for southern Nevada and highlighted a new paper analyzing new approaches to monsoon forecasting; and summarized information about how Nevadans can prepare for intentional power shutoffs during periods of very high fire danger.

In addition, the state climate office fielded nine general climate information requests, ten-plus information requests from state, municipal and Tribal agencies, and fielded 27 media requests from outlets ranging from local press and TV to the Washington Post, AFP and Now Tonight with Joshua Johnson.

Research, Projects and Publications

- The NSCO was a contributor to six active grants/contracts in 2022.
- 2022 – 2022: SRS RN: Planning Grant (Track 2): Nevada Water Research and Education Network. (PI: A Nolin, co-PIs: S McKenna, L Saito, J Edmonds, EA Marchand). National Science Foundation 2115432.
- 2021 – 2022: History of Climate Reporting in Nevada Exhibit. Nevada Humanities Major Project Grant (PI: G Barmore, V Zavataro, S McAfee, B Khoh*)
- 2021 – 2023: Evaluating Nevada’s drought monitoring network (D Simeral, DJ McEvoy, SA McAfee). National Integrated Drought Information System.
- 2021 – 2024: Improving drought communication in Nevada to enhance regional and local resilience (PIs: J DeDecker L Singletary , co-PIs: H Kratsch, M Rebori). US Department of Agriculture, Smith-Lever Special Needs Competitive Grants Program. Standard Grant 13305939.
- 2022 – 2027: California-Nevada Applications Program. Climate Adaptation Pathways-building capacity for near- and long-term resiliency in California and Nevada. NOAA RISA (PI: T Wall, DRI. coPIs: J Kalansky, D Cayan. Team: L Engeman, A Gershunov, T Corringham, A Pairis, D McEvoy, J Medellin-Azuara, J Thomason, J Selgrath, T Ott, T Smith, S Moser, S McAfee, M Dettinger, J Abatzoglou, E Bloomfield, K VanderMolen, T Benmarhnia, T Brown, Y Son, D Kauneckis, K Marcal. National Oceanographic and Atmospheric Administration, NA22OAR4310546.
- 2022 – 2025: CSSI: Elements: Innovating for Edge-to-Edge Climate Services Network. (PI: S Dascalu, co-PIs: FC Harris, SA McAfee, SD Strachan). National Science Foundation OAC - Software Institutes 2104101

2022 Publications related to climate services and Nevada climate included two student-led publications:

Canon C*, D Boyle, SA McAfee (2022) Visualizing the structure and development of climate communication research. *Journal of Science Communication*, 7, A03

<https://doi.org/10.22323/2.21070203>,

This paper was featured as a highlight on Wissenschaftskommunikation.de, a German science-communication website funded by the Federal Ministry of Education and Research and the Klaus Tschira Foundation.

Davis A*, SA McAfee, C Restaino, KJ Ormerod. Drought and Fire in Nevada: Is fire risk higher during drought? UNR Extension Factsheet. FS22-19

The History of Climate Reporting in Nevada Exhibit funded the successful development and run of “Where the wind blows wild and free: Understanding climate with science and art” at the W. M. Keck Earth Science and Mineral Engineering Museum on the University of Nevada, Reno campus.

The exhibit showed the links between science and art by showcasing early weather observers in Nevada who were also artists and by providing complementary perspectives on climate change from science and art.

In what is probably the highest honor for a climatologist in the West, the SC was asked to give the memorial Redmond lecture at the 2022 MtnClim meeting.

In addition to work that has come to fruition, the State Climatologist:

- participated in NOAA's Extreme Heat Tabletop Exercise – Las Vegas was one of the pilot cities;
- worked with the Desert Research Institute, the CA/NV DEWS, and the Nevada Division of Water Resources to develop a 3-webinar series and in-person meeting focused on drought planning in Nevada;
- is a chapter author for the Water chapter of the National Climate Assessment; and

Outreach and Education

The Nevada SC's primary role is as an educator. She provides internal support to students and faculty at the University of Nevada, Reno, connecting them with quality weather and climate information to support research, served on seven graduate committees, and taught two undergraduate courses.

Classic outreach opportunities were more limited this year, but the SC sat on a panel at the premier of a symphony about climate change. She also prioritized, as possible, attending events to raise the visibility of the state climate office: the Governor's Wildfire Briefing, the Nevada Cattlemen's Association Convention, attending meetings for the Clark-County climate resilience planning effort, and joined the Sustainability and Resilience Subcommittee supporting the Truckee Meadows Regional Planning Authority's Natural Resources Plan development.

Monitoring and Impact Assessment

Although the NSCO does not maintain a monitoring network, the office has been working toward building the foundations for a mesonet. The NIDIS funding to evaluate the drought monitoring network will move on to assessing priority monitoring locations and research in 2023. The NSF OAC grant is targeted partly at building software suitable for storing and providing access to environmental data transmitted by LPWAN, rather than cellular connection.

Office of the New Jersey State Climatologist

ARSCO Annual Report for Spring 2022 through Winter 2023

State Climatologist: David A. Robinson, PhD.

Assistant State Climatologist: Mathieu Gerbush

Staff/Service Climatologists: Dave Fittante, Jay Read, Chad Shmukler

Student Associates: Robert Bennett, Kyle Reiman, Meghan Anderson

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848-445-4741

<https://njclimate.org>

<https://www.facebook.com/NJWxNet>/<https://twitter.com/NJClimate>
david.robinson@rutgers.edu



About the Office of the New Jersey State Climatologist

The Office of the New Jersey State Climatologist (ONJSC) provides climate services to meet the needs of nine million Garden State residents, along with numerous stakeholders and decision makers. As we serve the NJ community, we continue to be mindful of our mission to gather and archive NJ weather and climate observations, conduct and foster research associated with NJ's weather and climate, and provide critical climate services to all seeking assistance.

The ONJSC is affiliated with the NJ Agricultural Experiment Station and is situated within the Rutgers Department of Geography. ONJSC staff includes the state climatologist, assistant state climatologist, technical specialists, field technicians, and student research assistants.

Communication Capabilities

The ONJSC primarily communicates via our main website and the Rutgers NJ Weather Network (NJWxNet) site. We also post reports on our Facebook page, have a Twitter presence, and maintain a mailing list of over 100 individuals (which includes some reporters). On average, there are nearly 3000 unique pageviews to our websites each day, the number fluctuating greatly depending on ongoing or recent weather/climate conditions.

Information Services, Products and Tools

Some specifics of ONJSC endeavors falling under this heading are found elsewhere in this report. For instance, a long-generated product is a fire weather page that provides US and NJ forestry staff with updates of weather conditions critical to assessing fire danger. A basic webpage includes observations updated every five minutes from several dozen NJWxNet, NWS, and RAWS stations, including fuel moisture and temperature measured at some locations. Based on stakeholder experience, watch, warning, and danger thresholds for each variable have been selected and when reached observations are color coded for rapid assessment. We are also about to launch our first app, commissioned by the Dam Safety program at the NJ Department of Environmental Protection. This uses NJWxNet data and other sources mentioned above to produce warnings to Dam personnel when excessive precipitation falls within basins over prescribed intervals.

Research, Projects and Publications

Research endeavors within the ONJSC include projects on issues including urban heat and public health, pest management, smart lawn watering, forest fire weather, public safety, transportation, potential seasonal ENSO influences, tropical systems, snowfall climatology, tornado climatology, and excessive precipitation events, to name a few. These efforts involve staff, students, Rutgers colleagues, and individuals within state and federal agencies, and the private sector. Project results are placed on the ONJSC and other websites, included within a variety of reports, as well as in some published literature. One of the most popular projects continues to be the ONJSC website posting of snowfall observations for any event depositing 2" or more snow at any location in the state. These observations are used to resolve snowplowing contracts that are based on increments of snowfall. The 2022-23 NJ winter was the fourth least snowy since 1895, thus this service took a good portion of the season off!

Outreach and Education

The ONJSC produces monthly reports of NJ weather and climate highlights, including societal impacts. These are shared with the Northeast Regional Climate Center, posted on ONJSC websites, published in the "Weather Shelter" newsletter of the North Jersey Weather Observers, and distributed via social media and to a distribution list.

Examples of ONJSC outreach activities include the creation of online weather training materials for NJ public safety officials, and a wealth of interviews and presentations. The ONJSC gave approximately 175 interviews to the media in the past year and made over three-dozen presentations to schools, civic, and other organizations; quite a few in person yet also many virtually.

Dave Robinson continues to sit on the NJ drought advisory committee and participates in NJ Office of Emergency Management's State Emergency Management Program Stakeholders (SEMPS). The ONJSC also continues providing consultation with the education community, the NJ Department of Environmental Protection, Rutgers Agricultural Research stations, and many other entities. Dave was also honored as the NJ Extension Specialist of the year by the NJ Agricultural Experiment Station.

Monitoring and Impact Assessment

The ONJSC operates the Rutgers New Jersey Weather Network (NJWxNet). This unique network of 66 weather stations serves as a one-stop Internet resource for New Jersey weather and climate data. The NJWxNet includes 52 NJ Mesonet sites monitoring a rich suite of atmospheric and surface variables, and 14 NJ SafetyNet stations, monitoring a subset of important variables primarily at public safety locations. Observations are gathered every five minutes and displayed in real time as colorful maps and tables on the NJWxNet web site. The NJWxNet site also displays data from NWS, USGS, NJDOT and other networks to augment NJWxNet observations.

The ONJSC oversees the NJ CoCoRaHS program. Over 300 citizen scientists participate in the program, with approximately 125 of them missing seven or fewer daily observations in 2022.

Observational data are used by myriad users, such as the NWS, the NJ Department of Environmental Protection, state, county, and local emergency management officials, the agricultural community, forest managers, snow removal entities, water utilities, schools, and the media.

New Hampshire State Climate Office

ARSCO Annual Report for 2022

State Climatologist: Mary Stampone

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University of New Hampshire

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https://twitter.com/nh_sco

mary.stampone@unh.edu



About the New Hampshire State Climate Office

The New Hampshire State Climate Office (NHSCO) resides within the Department of Geography at the University of New Hampshire (UNH) – Durham, a land, sea, and space-grant institution. In fulfillment of the UNH mission, the NHSCO:

- provides New Hampshire citizens and other stakeholders with climate information at the local, county, and state levels;
- conducts research on climate-related issues relevant to the state and its residents;
- is a climate science resource for citizens, government agencies, and educators.

The NHSCO provides the public with information on weather and climate through research, outreach, media interviews, and dissemination of data and analyses.

Communication Capabilities

The NHSCO disseminated information on weather and climate to a variety of users by telephone, e-mail, and online. The NH State Climatologist maintains an online presence via the web at <https://mypages.unh.edu/nhSCO/home> and on Twitter (@nh_sco). The State Climatologist regularly contributes to state agency press releases and public information statements on severe weather and drought as well as indicators and impacts of state/regional climate change.

- “Drought Has Emerged Across Most of the State, Groundwater Levels are Extremely Low in Areas and Limiting Outdoor Water Use is Advised.” NH Department of Environmental Services, August 11, 2022. (<https://www.des.nh.gov/news-and-media/drought-has-emerged-across-most-state-groundwater-levels-are-extremely-low-areas-and>)
- “UNH Research Warns New Hampshire’s Climate is Already Changing.” UNH Media Relations, June 29, 2022. (<https://www.unh.edu/unhtoday/news/release/2022/06/29/unh-research-warns-new-hampshires-climate-already-changing>)

She also distributes weather and climate data to the public through the media as part of local weather broadcasts as well as local and regional weather and climate reporting.

- “Climatologists warn Granite State about future climate trends in 2022 climate assessment.” Scott Cook, *WMUR9-TV*, March 15, 2022. (<https://www.wmur.com/article/climatologists-warn-new-hampshire-future-climate-trends-2022-assessment-3-14-22/39433637#>)

Information Services, Products and Tools

The NHSCO regularly provides information on weather and climate to users including state officials and agencies, local businesses, law enforcement, concerned citizens, K-12 and university faculty and students. In the last year, the NHSCO responded to dozens of data requests and regularly assisted citizens and students in accessing NCEI and RCC data products and tools. As a member of the state Drought Management Team, the State Climatologist continued to update the NH Department of Environmental Services (NHDES) on drought conditions and contribute to NHDES press releases.

- “August 2022 NH Drought Update.” New Hampshire Drought Management Team (DMT) Meeting, Concord, NH, August 8, 2022.

The State Climatologist also serves as a climate science resource for state agencies, community groups, and the media. Over the past year, the State Climatologist advised citizens, trade organizations, community groups and the media on the updated state climate assessment. Additionally, she participated in more than a dozen public forums and panel discussions on local and regional climate change and their impacts on human health, ecosystems, the economy, state infrastructure and operations, and water resources.

Research, Projects and Publications

The NH State Climatologist collaborated with university faculty and state agencies on climate science research in support of climate change assessment and impact studies. This includes the NHDES funded state climate assessment, which was published in June.

- Lemcke-Stampone, M.D., C.P. Wake, and E. Burakowski, 2022: *New Hampshire Climate Assessment 2021*. Report published by the Sustainability Institute, 71 pp, <https://scholars.unh.edu/sustainability/71>.

The State Climatologists of New Hampshire, Maine, and Vermont were awarded a NOAA Climate Adaptation Program grant to study the climate resilience and adaptation capacity of mobile home park communities across northern New England.

- “Collaborating Towards Increased Climate Resilience and Adaptation for Mobile Home Park Communities in Maine, New Hampshire, and Vermont.” [S.D. Birkel (PI), UMaine; M.D. Stampone (Co-PI), UNH; L.A. Dupigny-Giroux, D. Baker, K. Hamshaw (Co-PI’s), UVM]

As Chair of the Mount Washington Observatory’s Scientific Advisory Committee, the State Climatologist advised ongoing research conducted by Observatory staff including the QC/QA analyses on historical summit weather records and development of research-quality time-series of temperature and visibility. She also led the development of a 5-year research for the Observatory.

Outreach and Education

The NHSCO is regularly engages with schools, county cooperative extension services, citizen organizations, businesses, and academic institutions. In the last year, the NH State Climatologist presented on climate change in series of public library lectures and participated in Science Café and Science on Tap public panel discussions. She also presented relevant results from the updated state climate assessment to professional conferences, trade shows, and seminars focusing on the impacts of increased precipitation, drought, extreme heat, and warmer winters on water systems, transportation, agriculture, winter recreation, and ecosystems.

The NH State climatologist is also an Associate Professor at the University of New Hampshire and teaches undergraduate courses on weather, climate, and natural hazards in the Department of Geography. As a faculty member in the College of Liberal Arts, she was a featured speakers at several events across campus including events hosted by the Carsey School of Public Policy, Center for Humanities, and Museum of Art.

Monitoring and Impact Assessment

The NHSCO collaborates with state agencies, providing climate data and analyses for state environmental management and planning activities. The NH State Climatologist advised the Department of Environmental Services on state environmental monitoring and impact assessment activities related to climate change generally and more specifically extreme precipitation, flooding, and drought. The NHSCO serves as a member of the state's Drought Management Team and participates in the Northeast Region Drought Early Warning System (DEWS). The NHSCO also continues to work with the NWS Forecast Offices in Gray, ME to oversee operation and maintenance of state weather observing networks (e.g. USHCN – COOP, USCRN, CoCoRaHS). The State Climatologist serves as the NWS COOP observer for the USHCN/GHCN station at Durham, NH, and state co-coordinator for the NH CoCoRaHS network. She maintains the USCRN station pair located on the UNH campus in Durham, NH.

New Mexico State Climate Office

ARSCO Annual Report for 2022

State Climatologist: Dr. David DuBois

Staff/Service Climatologists: Stan Engle, Database administrator and ZiaMet guru

Student Associates: Natalie Franco, MS Graduate Assistant, Undergraduate Assistants, Brittany Hymer, Matias Coronado, Colton Burns and Eva Gulin

Department of Plant and Environmental Sciences

MSC 3Q PO Box 30003

Las Cruces, NM 88003

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Twitter: @NMclimate

Instagram: NMclimate

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About the NM State Climate Office

The New Mexico Climate Center (NMCC) resides within the Department of Plant and Environmental Sciences and the College of Agricultural, Consumer and Environmental Sciences at New Mexico State University in Las Cruces, New Mexico. The climate center is operated by the State Climatologist, one technician, and several student assistants. By law, the duties of the NMCC are to (1) assess the effect of climate on the natural environment, agricultural production, land and natural resources and human health, (2) coordinate climate impact studies and programs, (3) consult and coordinate with the federal and state agencies government in climate related activities, and (4) disseminate climate data, information, advice and assessments to state and local agencies and the general public.

Communication Capabilities

Our regular outlets for communication include Twitter (@nmclimate and @NM_CoCoRaHS) and Instagram (nmclimate) for providing climate information to the public. Our office fielded numerous media interviews from both local, state-wide, and national news organizations. The State Climatologist appeared several times on Albuquerque talk radio with KKOB about drought in NM and climate change. We regularly are interviewed and quoted in the following newspapers: Albuquerque Journal, Santa Fe New Mexican, and the Las Cruces Sun-News. We attended the 2022 American Meteorological Society Annual Meeting and presented a talk on the ZiaMet mesonet expansion project.

Information Services, Products and Tools

Our primary data service is to offer weather data from our state-wide ZiaMet mesonet. We maintain the website, <http://weather.nmsu.edu> to house our ZiaMet meteorological data at no cost to the public. Our office also coordinates the CoCoRaHS program for New Mexico and helps with recruitment and member retention. Many requests for data and information were also answered by phone and email. Dr. DuBois continues as the Chair of the New Mexico Drought Monitoring Workgroup and conducts monthly conference calls.

Research, Projects and Publications

The Climate Center continued to be funded by the NOAA RISA/CAP Climate Assessment of the Southwest (CLIMAS) to continue work in the area of climate services in New Mexico. Our office worked with the NMSU College of Engineering capstone program for students to continue work on an internet of things, automated rain gauge project using elements based on a CoCoRaHS gauge. Our office contributed to the New Mexico 50-year Water Plan Leap Ahead Project to assess the impacts of climate change on water resources. We collaborated with City University of New York on a project to determine the contribution of biomass burning in the New York and New Jersey metropolitan area.

Dunbar, N.W., D.S. Gutzler, K.S. Peartree, F.M. Phillips, C.D. Allen, D. DuBois, J.P. King, L.D.

McFadden, B.M. Thompson, A.C. Tillery (2022) Climate Change in New Mexico over the Next 50 Years: Impacts on Water Resources. New Mexico Bureau of Geology and Mineral Resources. A report prepared for the New Mexico Interstate Stream Commission, March 2022. <https://engagenmwater.org/hotter-drier-impacts-to-new-mexico-s-water-resources-from-climate-change-2020-2070>

Singh, Subraham, G. Johnson, D. DuBois, I.G. Kavouras (2022). Assessment of the contribution of local and regional biomass burning on PM_{2.5} in New York/New Jersey metropolitan area.

Aerosol and Air Quality Research 22, 220121, <https://doi.org/10.4209/aaqr.220121>

Outreach and Education

We also continued our active participation in the Joint Advisory Committee for the Improvement of Air Quality in the Paso del Norte Air Basin that met quarterly. We partnered with the USDA Southwest Climate Hub by contributing to several drought workshops. We continued to run the New Mexico State University Climate Change Education Seminar Series NMSUCCESS that brought in five climate change talks to Las Cruces. The talks were from: Bonnie Baxter with Westminster College, Derek Adams with EarthBridge Energy, Fernando Martinez with the New Mexico Renewable Energy Transmission Authority, Nuestra Tierra, filmmaker Michael Snyder, and a talk on the 50-year water plan.

Monitoring and Impact Assessment

In 2022 the NM Climate Center began a large scale expansion of the ZiaMet weather station network. We started with a 31 station ZiaMet network supported by the National Mesonet Program (NMP) and primarily located at NMSU Agricultural Science Centers across the state. The expansion was funded through the State Legislature with the goal of filling in gaps between the existing weather monitoring network. By the summer of 2022 we had more than 90 locations that were in the process of getting instrumented and telemetry. The January 2022 Legislative session brought more funds to ZiaMet with a bill that provided \$1 million to continue to expand the network and \$940K for annual maintenance. This year we

also were awarded \$1.82 Million from a Congressionally Directed Spending Request sponsored by Senator Heinrich. In 2022 our office was responsible for network design and new weather station locations for an additional 118 sites across the state. We acquired a contractor for the construction portion of the project to install the hardware and towers for the sites. We also sent out a request for proposals for the sensors and awarded Campbell Scientific the project. Due to the one-year funding duration of state funds, all 118 stations will be required to be installed in one-year.

State Climate Office of North Carolina

ARSCO Annual Report for 2022

State Climatologist: Dr. Kathie Dello

Assistant State Climatologist: Dr. Rebecca Ward, Mr. Corey Davis

Staff/Service Climatologists:

Dr. Timothy Glotfelty, Research Scholar

Mr. Sean Heuser, ECONet Manager/ State CoCoRaHS co-coordinator

Mr. John McGuire, Applied Meteorologist and Environmental Data Manager

Dr. Sheila Saia, Associate Director – ECONet

Ms. Myleigh Neill, Instrumentation Technician

Mr. LB LaForce, Instrumentation Technician

Lily Raye, PhD Student

Kaitlin Karaffa, PhD Student

Haven Cashwell, PhD Student/intern (Auburn)

Address:

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Centennial Campus Box 7236 Raleigh, NC 27695-7236

Phone: (919) 515-3056 **Website:** climate.ncsu.edu

Twitter: Email: @NCSCO sco@climate.ncsu.edu



About the NCSCO

The North Carolina State Climate Office (NCSCO) is housed in the College of Sciences at NC State University. NCSCO is the go-to resource for climate knowledge and information in the state, and serves the 11 million residents of North Carolina through outreach & education, research, and monitoring. Activities include collection and dissemination of climate information including operating a statewide mesonet; applied climate research with academic, state, and federal partners; education and outreach to K-12, college, and adult groups and close partnership with N.C. Cooperative Extension. NCSCO is committed to the improvement of the socio-economic conditions of NC and works with decision makers and end users in the public and private sector to co-develop tools, research, and outreach products to help navigate their climate challenges.

Demands of the North Carolina State Climate Office have increased over the past few years and continue to outpace capacity. The need for climate services in this country is greater than the capacity of any state climate office, CAP/RISA, CASC, or any other federally-funded effort. This report highlights just a few

of the many accomplishments from a team that works hard to serve North Carolina. This report serves to meet our ARSCO requirement for 2022.

Communication Capabilities

In 2022, NCSCO continued public science communication efforts through multiple means, including invited talks and outreach, interviews, publications to the office's Climate Blog, and Twitter posts (@NCSCO).

- During the year, new blog posts were published, including monthly climate summaries, seasonal outlooks, recaps of significant events, and a 5-part series on "Our Curious Coast," exploring the science and the stories of North Carolina's Coast. NC State University's College of Sciences also shared several of these posts on their news site, <https://sciences.ncsu.edu/news/>.
- The NCSCO Twitter account remains popular and features tweets about North Carolina's weather and climate, with 2700+ followers
- NCSCO staff gave over 100 invited talks on climate change, climate impacts, and the weather and climate of North Carolina.
- NCSCO staff completed more than 100 interviews in the past year with local, regional and national news media on topics that ranged from recent weather events and their climatological significance, climate change, and information about the office. Of note:
 - NCSCO's Davis participated in over 50 weekly interviews with the Southern Farm Network discussing the state's current drought status, recent and forecasted weather, and its impacts on the agriculture sector.
 - NCSCO's Dello is frequently cited by the national media on high-profile climate stories of interest

Information Services, Products and Tools

Cardinal and Station Scout, two high-powered tools to allow access to North Carolina weather and climate data, serve up 95% of the office's data requests. These products replace a traditional data request form, allow researchers and state government free access to our databases, and allows users to make plots and other figures. Both tools are updated and enhanced on a quarterly basis, as a response to user feedback and needs. The SCONC has estimated that this saves about 200 person hours/year.

Research, Projects, and Publications

New Host of NOAA's Regional Integrated Sciences and Assessment (RISA) for the Carolinas The State Climate Office (Dr. Kathie Dello), in conjunction with the North Carolina Institute for Climate Studies (Dr. Jennifer Runkle) and the College of Natural Resources (Dr. Louie Rivers), kicked off work on NOAA's Carolinas RISA, a 5-year, 5.4 million dollar grant to help communities build climate resilience. The center had been located at the University of South Carolina for 19 years. The new NC State-led center will focus on justice, equity, diversity, and inclusion at the forefront and build upon

decades of climate work in the region. Co-PIs are located at North Carolina Central University, UNC Chapel Hill, South Carolina State University, Clemson University Furman University, and the NC Museum of Life and Science.

Initial community partnerships for CAP/RISA are the Eastern Band of Cherokee Indians, The Albemarle Regional Health Services, Down East, and compound hazards work in Raleigh and Durham

Other grant funding was secured from Duke University to create a water supply dashboard and from North Carolina Office of Resiliency and Recovery (NCORR) to create IDF curve visualizations and to model flood risk in Carolinas communities.

Outreach and Education

NCSCO staff and students participated in educational outreach events in the past year with the NC Museum of Life and Science, the NC Museum of Natural Science, and many K-12 schools. These were largely remote due to COVID-19. NCSCO's Heuser is also the state's CoCoRaHS co-coordinator, providing new ideas and creativity to recruit new observers and retain current observers.

The State Climate Office and the Science House collaborated on upgrades to SCONC's Climate Education modules. The new modules better reflect weather and climate risks that are relevant to North Carolina, and adhere to statewide educational standards for Weather and Climate in the Classroom. These updates were motivated by increased requests for weather-related information from parents and teachers working from home as a consequence of the onset of the COVID-19 pandemic.

As indicated above, SCONC is heavily invested in community outreach activities. Another example of Center activities in this realm is its partnership with Carteret County 4-H to pilot the development of weather-climate 'kits' to supplement 5th-grade teachers' weather units at Bogue Sound Elementary. SCONC modified lessons developed with NC State's Science House to meet specific needs of teachers (e.g., preferred topics, time constraints), and purchased and organized supplies for 15 kits (5 lessons x 3 classrooms). Carteret County 4-H collected input from teachers on instructional and content needs, and coordinated with the elementary school to implement these kits in spring 2022.

In the last two years, the number of requests from colleagues at the NC State Extension Service for SCONC presentations about climate change has increased substantially. To aid in meeting this demand, SCONC developed a climate change curriculum and three-part lesson series that covers (1) the science of climate change; (2) North Carolina's changing climate and impacts in the state; and (3) climate solutions. In addition, slides and lecturer's notes are available for educators who would like to incorporate these materials into their programs. These presentations are posted online and were developed to target specific audiences and are also available for access by the general public.

Monitoring and Impact Assessment

NCSCO staff participate in the weekly North Carolina Drought Management Advisory Committee meetings in Raleigh.

The North Carolina Environment and Climate Observing Network (ECONet) is a network of research grade weather stations maintained by the NCSCO, led by NCSCO's Heuser with support from Neill, Saia, and Laforce. To better understand heat stress, black globe thermometers were added to all 44 sites in the NC ECONet network rendering it the only state Mesonet with black globe thermometers installed. Staff use ECONet data to create custom web tools and dashboards to issue alerts for the safe spraying of herbicides based on atmospheric conditions. ECONet provides key partners, like the National Weather Service and the NC Department of Emergency Management, with critical weather observations required for agriculture, transportation, and public safety. The latest ECONet station was installed in Nags Head, NC in July 2022. There are now 44 stations.

Occasionally, smaller stations with fewer sensors are deployed outside the formal ECONet network. These low-cost stations, called ECONet Extended stations, serve the needs of groups not able to afford the opening of a full station. The newest ECONet Extended station installed in early 2022, in collaboration with the Center for Energy Education (C4EE) in Roanoke Rapids, provides public access to data.

North Dakota State Climate Office

ARSCO Annual Report for 2022

State Climatologist: F. Adnan Akyuz

North Dakota State University
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Telephone: 701-231-6577

Website(s): <https://www.ndsu.edu/ndSCO/>

Twitter: <https://twitter.com/FAkyuz>



About the North Dakota State Climate Office

The North Dakota State Climate Office (NDSCO) is part of the [North Dakota Agricultural Experiment Station](#) in the [College of Agriculture, Food Systems, and Natural Resources](#) of the [North Dakota State University](#). The State Climate Office (NDSCO) is in a position to provide linkages and to serve as a liaison between the users of weather and climate information in the state of North Dakota and the national and regional climate centers such as the National Centers for Environmental Information (NCEI), National Weather Service (NWS) and the High Plains Regional Climate Center (HPRCC). The State Climate Office provides the information needed for natural resources management and climate assessment to the College of Agriculture, Food Systems, and Natural Resources, the University, and other public and private educational institutions, corporations, and government agencies throughout North Dakota and elsewhere. The NDSCO has been an AASC Recognized State Climate Office since 2007. The NOAA Weather Forecast Offices in BIS and FGF, as well as HPRCC and NCEI, support the NDSCO via a Memorandum of Agreements.

Communication Capabilities

The State Climate Office disseminates climate information quarterly, monthly, and seasonally. These reports are available at www.ndsu.edu/ndSCO/climatesummaries/. The SCO also frequently answers media and public questions. A list of outreach activities follows.

Information Services, Products, and Tools

- The North Dakota State Climate Office enjoys full access to a State Mesonet: North Dakota Agricultural Weather (NDAWN): <https://ndawn.ndsu.nodak.edu/>
- Statewide Climate Data (NDSCO): www.ndsu.edu/ndsco/data/
- Climate Summaries (NDSCO):
 - Monthly Climate Summary and Impact Reports: www.ndsu.edu/ndsco/climatesummaries/monthlyclimatesummary/
 - Quarterly Climate Bulletins: www.ndsu.edu/ndsco/climatesummaries/quarterlyclimatebulletin/
 - Annual Climate Summaries: https://www.ndsu.edu/ndsco/climatesummaries/annual_climate_summaries/

Refereed Publications

1. Subhashree, S.N., Igathinathane, C., Akyuz, A., Borhan Md., Hendrickson, J., Archer D., Liebig M., Toledo D., Sedevic K., Kronberg S., and Halvorson J., 2023. Tools for Predicting Forage Growth in Rangeland and Economic Analysis — A Systematic Review. *Journal of Agriculture*. 13(2), 455; <https://doi.org/10.3390/agriculture13020455> (Submitted in 2022, Published in 2023)

Technical Reports: Total

1. Umphlett, N.A., M. Woloszyn, B.A. Parker, F.A. Akyuz, A.R. Bergantino, S. Brotherson, D. Crow Ghost, M. Downey, L. Edwards, T. Hadwen, Z. Hoylman, K. Jencso, W. Kelley, A. Klein, D. Kluck, D. Longknife, K. Low, R. Mahmood, M. Meehan, G. Rush, C.J. Stiles, and S. Tangen. 2022. 2020–2021 Drought in the U.S. Northern Plains and Canadian Prairies: Initial Assessment of Impacts and Response to Build Resilience During an Ongoing Drought. NOAA National Integrated Drought Information System. (<https://www.drought.gov/documents/2020-2021-drought-us-northern-plains-and-canadian-prairies>)

NDSU Extension Publication:

1. Kandel H., M. Rahman, A. Akyüz, M. Ostlie, B. Hanson, L. Henry, R. Duerr, E. Ericsmoen, A. Kraklau, J. Hansen, G. Pradhan, J. Jacobs, A. Turnquist, T. Tjelde. North Dakota Canola Hybrid Trial Results for 2022 and Selection Guide. 2022. NDSU Extension Services/ ND Ag Experiment Station. A1124-22. November 2022.
2. Kandel H., N. Bandillo, A. Akyüz, M. Ostlie, J. Rickertsen, M. Wells, B. Hanson, L. Henry, R. Duerr, G. Pradhan, C. Sperling, J. Bergman, E. Ericsmoen, J. Hansen, A. Kraklau, G. Martin. North Dakota Dry Pea Variety Trial Results for 2022 and Selection Guide. 2022. NDSU Extension Publication # A1469-22. November 2022.

Outreach and Education

- Media Interaction (30 Documented)
- Professional/Invited Presentations (14 total)
- Guest Lectures/K-12 Presentations (3 total)

- Communicated various topics related to climate change, impact, and climate outlook for the coming growing seasons with the target audience through workshops and farm meetings, including but not limited to North Dakota Commodity Groups Meeting, Ag Improvement Association annual meetings of various counties in ND as well as in MN, Farmers' Union meetings, International Spring Wheat Show.
- The SCO communicated the state of climate and its impact with the target audience through monthly and quarterly bulletins: www.ndsu.edu/ndsco/climatesummaries/.

Education:

Teaching: Total Student Population Served in 2022= 569 students

Spring 2022: Soil 217/Introduction to Meteorology and Climatology (Class Size: 69)

Fall 2022: AGRI 115/Wonders of Weather (Class Size: 500)

Advising:

- Ph.D Program: 1 Students

Awards:

- Recognition for Innovation in Teaching for developing and promoting innovative teaching at NDSU. The award was announced on Dec 14, 2022.

Award Nominations:

- 2022 Governor's Harvest Award for Excellence in Quality.

Service Impact to the State and NDSU Community

- The SC became a critical source of information in the State for FEMA to put forward federal relief programs for the State of N.D. during qualified natural disasters. The following lines were entered from the notification letter for Governor's Awards for Excellence in Public Service:

The State of North Dakota continues to reap the benefit of Adnan's passion for making the State safer. His expertise and quality of product in the field of climatology has helped our State receive federal aid for seven Presidentially Declared Disaster Events, providing more than \$100 million in federal funds to state agencies, local and tribal governments, and private non-profit organizations impacted by floods, severe winter storms and severe summer weather events. As NDDES Disaster Recovery Chief Justin Messner said,

"Without Dr. Akyuz's analyses, it is very possible that our state would not have been approved for any federal support, and our communities would have been required to address their damages using their pre-existing budgets which were not built to address damages caused by a natural disaster."

- The SC provided a critical and detailed analysis of April storms that resulted in heavy snowfall, high winds, low visibility, blizzard, interstate closure, power outage, flooding,

infrastructural damage, and property loss to the Governor's office that prompted the following Executive Orders:

- [Executive Order 2022-04](#): Declaration of Disaster for Historic Blizzard.
- [Executive Order 2022-05](#): Declaration of Statewide Emergency for Flooding, Infrastructure Damage.
- [Executive Order 2022-09](#): Declaration of Winter Storm Disaster for November Storm.
- The SC's analysis for the April 22-24 storm was used as an attachment to the President's request for a Presidential Major Disaster Declaration. In his letter, Governor Burgum continually mentioned and relied on my synopsis of the storm. The letter of the request can be found at this link: (<https://www.governor.nd.gov/sites/www/files/documents/Burgum%20Letter%20Requesting%20Presidential%20Disaster%20Declaration%2006.23.2022.pdf>). It was announced in a press release on July 14, 2022, with the following title: "[Biden grants Burgum's request for presidential disaster declaration for spring storms, subsequent flooding](#)" I would like to believe my analysis played a crucial role in the \$57M FEMA aid that would help 40 counties that were impacted by the storm.
- The SC is an integral Campus Severe Weather Protocol Crisis Management Response Team member chaired by the V.P. for Finance and Administration. Our focus widened to help the entire F.M. area colleges and school districts make informed decisions about school closures to keep the community safe during inclement weather events such as heavy snowfall, blizzards, dangerous wind chills, and tornado threats.
- The SC is a member of the ND Ag Disaster Response Team of NDSU Extension, the Farm Service Agency, the Governor's office, the Ag Commissioner's office, the Forest Service, the Department of Human Services, the Department of Water Resources, and congressional representatives. In 2022, I briefed the committee on drought emergencies bi-weekly.
- The SC is the drought designation recommender to the National Drought Monitor protocol in the State. Every week in 2022, I collected drought impact reports from each county, supplemented with meteorological data. I coordinate with my regional counterparts in S.D., MT, MN, and Manitoba to make a final recommendation to the drought monitor. I made 34 "Drought (Map) Recommendations" that required a change in the drought designation after careful analysis utilizing the convergence of evidence from multiple sources (including but not limited to meteorological data, soil moisture, snowpack, multiple drought indices, NDSU Extension County agent reports). These analyses and my recommendation to the Drought Monitor author are archived and available upon request.

The SC is a delegate for N.D. Extension Disaster Education Network (EDEN)

(<https://extensiondisaster.net/directory/f-adnan-akyuz/>). We meet once a month about the current disasters and strategies to prepare and assist local communities against designated disasters such as drought and floods

Oklahoma Climatological Survey

ARSCO Annual Report for 2022

Dr. Kevin Kloesel OCS Director

Dr. Chris Fiebrich OCS Associate Director and Executive Director, Oklahoma Mesonet

Cindy Luttrell Deputy Director of the Oklahoma Mesonet

Gary McManus State Climatologist

Dr. Mark Shafer Associate State Climatologist & Director of SCIPP

Monica Mattox Assistant State Climatologist

James Hocker OK-FIRST Program Lead

Andrea Melvin K-20 Program Lead

Dr. J.D. Carlson (Oklahoma State Univ.) OK-FIRE Program Lead

Wes Lee Mesonet Agweather Lead

Oklahoma Climatological Survey

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<http://climate.ok.gov>

<https://twitter.com/okmesonet>

<https://www.facebook.com/mesonet>



About the Oklahoma Climatological Survey

The Oklahoma Climatological Survey, a research unit of the College of Atmospheric & Geographic Sciences at the University of Oklahoma, was established in 1980 to provide climatological services to the people of Oklahoma, conduct research on the impacts of climate on human activities, and serve as a support facility for the State Climatologist. OCS has a legislative mandate to acquire, process, and disseminate climate and weather data and information for use by the state's citizens. The Survey maintains an extensive array of

climatological information, operates the Oklahoma Mesonet, and hosts a wide variety of educational outreach and scientific research projects.

Communication Capabilities

The Oklahoma Climatological Survey communicates and disseminates data and climate weather information through the following sources:

- Websites
 - <https://climate.ok.gov/> OCS's governing website, which then links to other programs' websites within OCS.
 - <https://www.mesonet.org/> The website of the Oklahoma Mesonet, which disseminates weather information from the network's 120 sites every 5 minutes, 24 hours/day, 365 days/year. The website has hundreds of thousands to millions of views each month, depending on weather events. This website also links to the Mesonet's various outreach programs: K-20 Education, Agriculture, Public Safety, and Fire Management.
 - <http://www.southernclimate.org/pages/> - The website of the RISA Southern Climate Impacts Planning Program.
- Social Media
 - Twitter: <https://twitter.com/okmesonet/> - OCS personnel often make multiple posts/day conveying climate and/or weather data. The Mesonet's Twitter page has 22,700+ followers, and its "Tweet Impressions" can range from 100 thousand to 1 million per month.
 - Facebook: <https://www.facebook.com/mesonet/> - The Mesonet's Facebook page has 40,000+ unique followers (or individuals "liking" the page), with its posts reaching from several hundred thousand to more than a million people per month.
- Mobile Apps: The Mesonet has apps for both Android and Apple devices that deliver mobile versions of Mesonet websites and their contents.
- OCS/Mesonet Ticker: The Ticker is blog style e-mail service that goes to 1050+ subscribers 4-5 days/week. It is an attempt to impart weather and/or climate information and expertise in a casual tone to a general audience. Subscribers range from individual citizens to the Oklahoma Governor's office, Oklahoma state and federal legislators, and state agency heads. The blogs are also posted on the Mesonet's social media pages, as well as on our web-based and mobile platforms.

Information Services, Products and Tools

- OCS fulfilled 130 e-mail data requests during 2022, in addition to hundreds of requests for quotes or data/information from customers.
- OCS published 12 official press releases, which are picked up by many of the state's newspapers—large and small—and other media outlets.
- OCS sent 185 OCS/Mesonet Tickers to subscribers and social media platforms, resulting in numerous media requests.
- Assistant State Climatologist Monica Mattox finalized and completed the redesign of its County Climate Summaries in 2021, the first format change in the product in 18 years, using a mixture of Mesonet and NWS COOP data to highlight the climate across Oklahoma's 77 counties. Monica then updated the package with the new 1991-2020 normals in 2022. Typical climate normals are available, along with supplemental data. The revamped summaries are posted on the OCS Climate portion of its website.
- Drought that had its origins back in mid-Fall 2021 was mostly eradicated across the state during prolific rains from April through mid-June. A sudden lack of precipitation and the worst summer heat seen in the state since the historic Summer of 2011—the hottest on record for Oklahoma—prompted drought to roar back during July and August before peaking once again in October. By that period, more than 86% of Oklahoma was considered to be in at least Extreme (D3) or Exceptional (D4) drought according to the U.S. Drought Monitor. A significant portion of State Climatologist Gary McManus' time was spent dealing with drought concerns, from soliciting data to provide to the U.S. Drought Monitor in his role as Oklahoma's "local expert" to answering media requests.
- Gary was also invited by Oklahoma Secretary of Agriculture Blayne Arthur to address the Emergency Drought Commission convened by Gov. Stitt. The Emergency Drought Commission decides who gets the millions in emergency aid provided by state government. Gary's role was to update the Commission on current and future drought prospects.
- Gary along with OCS Director Kevin Kloesel was asked to give a drought update on the opening morning of the Governor's Water Conference in early December. Gary focused on the past and current drought picture while Kevin presented on the difficulty of forecasting.
- Dr. Brad Illston updated the tornado by county map for the Oklahoma Climate website, created custom chill hours maps for an Oklahoma State University Associate Extension Specialist, and generated the 3D rainfall models for 2020 and 2021 for use in outreach activities. He also performed testing of the

new soil matric potential formulas, which should be deployed to our website and products next quarter.

- Brad also assisted a private citizen on rainfall data (wind turbine impacts), a Master's student on Mesonet rainfall interpolation methods, a NASA scientist in understanding the instrumentation used in the OKC Micronet, and a University of Arizona researcher with Mesonet soil moisture data. He also attended monthly meetings with other state surveys led by the Institute for Resilient Environmental and Energy Systems.

Research, Projects, and Publications

- Brad represented the Oklahoma Mesonet at the Annual Meeting of the AMS where he presented or co-presented presentations entitled “All-In-One Meteorological Observing Sensors: Statistical Comparison, Durability Analysis, and Design Recommendations”, “Multi-seasonal Albedo Measurements in Central Plains Grasslands”, “An Examination of the Accuracy of Objective Analysis Schemes”, “Analysis of Heat Bursts across Oklahoma from 2014 to 2020 using Dew Point Depression Ratios”, and “Supporting Student Skill Building While Exploring Convergent Research Through a Hands-on Experience with Scientific Instrumentation”.
- Brad continued to work with OU researchers and City of Oklahoma City colleagues on potential plans for a re-emergence of the OKC Micronet for both research and operational use. A Department of Energy grant proposal is being drafted by OU researchers to cover operational and research costs for the project.
 - Brad, Monica, and Robby Frost worked with the scientists and engineers at NASA JPL on the corner reflector project, where they attended meetings, identified landowners, performed site maintenance and visited potential site locations. In June, they deployed six new corner reflectors for the SWOT mission. One final deployment for this mission will occur in the Fall before the satellite launch in November.

Outreach and Education

Public and stakeholder outreach were again a prime focus of OCS during 2022, including the Oklahoma Mesonet's public safety, K-20, Climate and Data Services, and agricultural programs.

- The Mesonet's public safety outreach program, OK-First, has been recognized for its innovative approach in providing instant access to a wealth of vital weather data for public safety agencies. OK-First also provides instructional

resources for the public safety community, led by OK-First manager James Hocker.

- Spring 2022 was the first OK-First training season since fall 2019 with a full slate of in-person classes. It was also the first season in program history in which all class types (certification and re-certification classes) were offered in both in-person and online formats. This is likely the “new normal” for OK-First training moving forward as class surveys have consistently shown no consensus in training format preference.
- The final OK-First class of the year was an online certification class during October 10 – November 20, 2022. It was successfully completed by 24 people. This brought the annual number of people to complete OK-First certification in 2022 to 149 people (an all-time program record). Considering all class types (certification and re-certification), 2022 ended with a total class attendance of 516 people. This represents the third highest annual training total in program history and trails only 2021 (554 people) and 2020 (537 people) when nearly all classes were held online. With classes offered in both in-person and online formats in 2022, OK-First in-person training presence was increased from 4% of the total in 2021 to 30% in 2022. Our goal for 2023 is to continue to increase the in-person training percentage.
- Andrea and James also attended the annual Oklahoma Emergency Management Association conference which was held in Durant March 28-31. We provided an OK-First re-certification class as part of training day, had a booth in the exhibitor hall to distribute shirts & coins, and had an opportunity to re-connect with our partners in person for the first time in several years. Also during the conference, Andrea and James were awarded the “2022 Outstanding Contributor to Emergency Management” at the conference banquet.
- The Mesonet’s K-20 outreach program, led by Andrea Melvin, provides accurate, useful, and exciting learning activities using meteorology, climatology, environmental data, high-quality software, and educational content standards. K-20 outreach led OCS’ outreach efforts by participating in dozens of activities and presenting to thousands of students and teachers.
- Andrea assisted in the Science Olympiad’s virtual, invitational meet; the virtual, regional meet; and the in-person, state meet held at University of Central Oklahoma in Edmond. Andrea Melvin was the Event Supervisor for all three competitions.
- Andrea met in-person with a FFA class at Norman High School on March 24th. She had been scheduled to visit this group in 2020 but had to cancel when

the university switched to work-from home. This was her first visit back inside a school since March of 2020.

- Andrea received the 2022 Informal Educator award from the Oklahoma Science Teaching Association (OSTA). This is a new award category that was added when the “T” in OSTA changed from “Teachers” to “Teaching”. Both the national and state associations voted to change their names several years ago to be more inclusive of teaching at all levels from PK-12 to university/community colleges along with informal educators at museums, zoos, and state agency outreach staff.
- Andrea Melvin traveled to Ada for the FemStem summer camp in July. FemStem is sponsored by the Chickasaw Nation and works with middle-school female students to give them opportunities to interact with female STEM professionals. Andrea worked with the students to complete the Storm
- The National Weather Festival was held in-person on October 21st. Mesonet-branded beanies, coffee mugs, and insulated mugs were available for purchase. We sold out of most of our older shirt inventory. Mesonet staff had many positive interactions with members of the public at the Crawford Demo Tower and at our booth near the OCS entrance. Staff who helped during the festival included Nick Alonzo, Trey Bell, Amanda Bryant, Chris Fiebrich, James Hocker, Brad Illston, Joel Kirschenman, Michael Klatt, Wes Lee, Andrea Melvin, Brad Stanley, and Misty Wilson.
- The Mesonet’s Agricultural outreach program, Agweather, is a cooperative project between Oklahoma State University, the University of Oklahoma, and the Oklahoma Climatological Survey. The professionals and faculty from these three institutions bring together expertise in the areas of meteorology, climatology, agricultural production, and natural resource management. Agweather team leader and OSU Extension Specialist Wes Lee attended dozens of agricultural related in-person and virtual events on behalf of the Mesonet during 2022, providing either booths or educational talks.
- Wes Lee and Gary McManus produced 48 Mesonet Weather segments for OETA’s SUNUP-TV program, airing most Saturday and Sunday mornings.
- To aid our Ag Outreach efforts, Andrea helped with the booth for Water Day at the Capitol. She also provided support during the OSU Ag Educators workshop. She traveled to Weatherford for the Deer Creek Conservation Outdoor Classroom event for 4th graders, and she made two trips to Purcell for the McClain County Outdoor classroom days. Andrea provided a full tour of the NWC to the National Farm Council.

Monitoring and Impact Assessment

OCS houses the Oklahoma Mesonet, a world-class network of environmental monitoring stations. The network was designed and implemented by scientists at the University of Oklahoma (OU) and at Oklahoma State University (OSU). The Oklahoma Mesonet was commissioned on January 1, 1994, and consists of 120 automated stations covering Oklahoma. There is at least one Mesonet station in each of Oklahoma's 77 counties. At each site, the environment is measured by a set of instruments located on or near a 10-meter-tall tower. The measurements are packaged into "observations" every 5 minutes, then the observations are transmitted to a central facility every 5 minutes, 24 hours per day year-round. The Oklahoma Climatological Survey (OCS) at OU receives the observations, verifies the quality of the data and provides the data to Mesonet customers. It only takes 5 to 10 minutes from the time the measurements are acquired until they become available to the public.

- Gary McManus serves as the de facto drought expert for the State of Oklahoma, and handles the primary role of drought input for the state to the U.S. Drought Monitor. Drought once again took center stage of Oklahoma's weather headlines by the end of the year. Drought first began to get a toehold in early fall 2021, which then had exploded through the end of December thanks to an unusually warm December. December 2021 ended more than 10 degrees above normal and was particularly windy, which produced flash drought type increases that are often reserved for the warm season in the state.
- OCS produces monthly climate summaries for Oklahoma, which are then archived on the OCS website. Significant weather events are noted within the reports, with associated impacts. The reports are also released to the media as press release on the first business day of each month.

Pennsylvania State Climate Office

ARSCO Annual Report for 2022

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Staff/Service Climatologists: Arthur Person

Affiliation/sponsor: Pennsylvania State University

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Facebook: <https://www.facebook.com/PAClimateOffice>

Twitter: @PAClimateOffice

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About the Pennsylvania State Climate Office

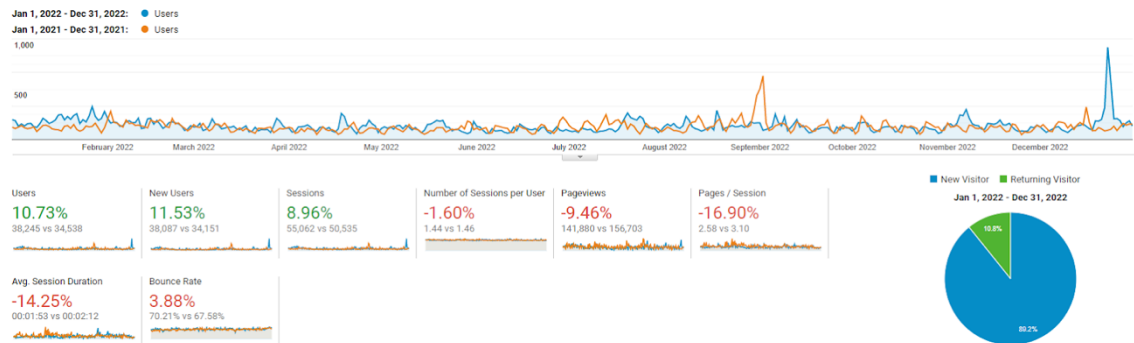
The Pennsylvania State Climate Office, housed within Penn State's College of Earth and Mineral Sciences, provides support and services to numerous users and clients across the state spanning numerous economic sectors such as agriculture, transportation, and energy. In 2022, the Pennsylvania State Climate Office has continued to expand its role in the state's mesonet expansion efforts, including continued collaboration with the National Mesonet Program and development of the new Pennsylvania Environmental Monitoring Network, with 17 sites installed by the end of the year. The CoCoRaHS network continues to expand across Pennsylvania under the auspices of the state climate office. By the end of 2022, nearly 1600 volunteer observers comprise the network, with 99 new observers joining in the annual year. Typically, around 200 faithfully report each day.

Communication Capabilities

Development of new products has mainly focused on grant-related items, such as those connected with data inventory and display. Along with grant-related decision-support tools and initiatives, a new electronic data request submission tool has been developed, and is now displayed on our office home page, to allow for tracking of request counts and for users to request information more easily. Last year, data requests were received at a rate of approximately 3-5 requests per week.

Website Analytics:

- Website user counts were up about 10% compared to the previous year, partly driven by the Arctic outbreak that occurred just before Christmas, when we had close to 1000 users visit the site on December 23rd alone. About 60% of the visitor base came from Pennsylvania, followed by between 5 and 7% in Virginia and New York.
- Our most viewed web pages were from Philadelphia's city information/data page, the statewide records page, and a page dedicated to our PEMN site at Kinzua Bridge State Park.



Information Services, Products and Tools

The Interactive Data Archive continues to provide data that includes data queries for specific dates and strings of dates. An archive of high-impact weather events in the Mid-Atlantic region is also available. In addition, provisional climate divisional data will continue to be updated to more closely reflect data available from NCEI. A monthly newsletter is sent out at the beginning of each month by the climate office that provides a summary of the month's weather in the state, a climate highlight that focuses on climate science and long-range forecast topics, and a 2-month forecast based on analog forecast techniques. There are currently about 200 active newsletter subscriptions. The office receives about a dozen data requests per month, with primary users comprised of commercial, educational, and government organizations.

Research, Projects and Publications

- Mesonet Efforts:
 - Synoptic, Inc. has collaborated with the climate office regarding the National Mesonet Program by contributing metadata from the COPAMS (DEP's air quality network) as well as sub-hourly data sets. In addition, data streams have been established in collaboration with the Pennsylvania Turnpike Commission and the Allegheny County Health Department. These datasets are being sent to MADIS in real-time, as well.
 - The Pennsylvania Environmental Monitoring Network was established in the NMP data feed in 2020 and the network has grown to 17 sites by the end of 2022. These sites include soil property data, snow depth measurements, and a full suite of 2m and 10m atmospheric variables. The final three sites of the initial 20 site funding allocation will be installed in 2023.
 - PEMA has funded the PA Climate Office/PSU to research potential locations for 30 new sites to expand the existing PEMN network. The purpose of the expansion is to focus on inland flooding potential and develop real-time alerting capabilities for emergency managers based on the high-frequency data. In Summer 2022, funding was provided to PEMA to install 30 new sites across the state with units that are identical to the initial 20 PEMN site setups.
 - Our partnership with Campbell-Scientific has allowed for expansion of services provided by the Campbell Cloud portal to support our PEMN metadata collection and data ingest/display efforts. In addition, the Campbell Cloud team has developed a beta alerting system that supports our Keystone Mesonet project through the Pennsylvania Emergency Management Agency.
 - During 2022, work continued on optimizing database structures, expanded use of snowfall data from PEMN sites, and expansion of mesonet applications to decision-making and risk assessment tool development.
- The Pennsylvania State Climate Office continues to contribute monthly state weather summaries, including its societal impacts, to the Northeast Regional Climate Center during all of 2022.
- In partnership with Kansas State University and Ohio State University, the Climate Office provides meteorological data in support of risk assessment for specific wheat-related diseases like Fusarium Head Blight. A real-time user interface has been developed and new model development remains an essential part of the work.

Outreach and Education

The Pennsylvania State Climate Office provides numerous talks to agricultural conferences and meetings during the year. In additions, training sessions for weather observational networks are provided upon request.

The Climate Office has participated in workshops and round tables to discuss the new mesonet initiative the office has created. The office continually receives feedback from partners and stakeholders to improve tools developed as a result of mesonet data.

A climate studies course is taught each semester that allows undergraduate students to be exposed to the daily work of a state climate office. These students are able to assist with numerous research grants and data quality control of our datasets. Office staff also provide support for courses in agricultural science and weather forecasting.

Monitoring and Impact Assessment

- Collaboration with experts at Kansas State University continues with the refinement of environmental data monitoring systems for a Fusarium Head Blight/Wheat Blast project (also discussed in Research section).
- As discussed in the Research section, PEMA is working closely with the PA State Climate Office to develop the Keystone Mesonet. This network will not only provide real-time weather data access, but plans are in place to develop impacts-based decision support tools tailored to emergency management personnel across the state. Real-time alerting was launched in Spring 2022 with about 150 emergency managers actively using the system as a test of the system. The system will be re-vamped and expanded over the coming years.
- Both the PEMN and Keystone Mesonet initiatives will provide numerous opportunities for weather-driven decision support and statewide impacts assessments over time.

South Carolina Office of Climatology

Hope Mizzell, Ph.D., State Climatologist
Melissa Griffin, Assistant State Climatologist for Service
Frank Strait, Severe Weather Liaison
Elliot Wickham, Ph.D., Water Resources Climatologist
Caiden Dinkins, Research Intern (May 2021 – May 2022)
Taylor Allred, Research Intern (September 2022 – December 2022)



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Created in 1986, the Office of State Climatology (SCO), as mandated by the South Carolina General Assembly (Section 49-25-10 et seq., Code of Laws of South Carolina, 1976), serves as the State focal point for activities pertaining to the weather and climate of South Carolina. The SCO resides within the South Carolina Department of Natural Resources (SCDNR). A primary mission of the office is to advance the use of climate information for the economic and environmental benefit of South Carolina and for the public safety of its citizens through climate monitoring, research, outreach, and information services.

The SCO provides a unique service to the state by archiving and distributing climate and meteorological data, reports, and research that date back to the late 1800s. The SCO administers the *South Carolina Drought Response Act*, which requires the office to formulate, coordinate, and execute a comprehensive drought response program for the State of South Carolina. The SCO serves as a liaison between the National Weather Service and State agencies, such as the Governor's Office, SC Department of Public Safety, and State Emergency Response Team and the SC Emergency Management Division. The SCO assists other State and Federal agencies in data acquisition and interpretation before, during, and after periods of severe weather.

ARSCO Qualifications: The following describes the ways in which the SCO addressed each of the ARSCO qualifications during 2022:

Communication Capabilities:

- The office expanded the SCO website (<http://www.dnr.sc.gov/climate/sco/>). Products and links were updated as needed.

- The office expanded the email notification system focused on severe weather and tropical advisories. Subscribers increased from 38,827 subscribers as of January 2022 to 45,726 subscribers as of November 2022.
- The SCO expanded social media presence via Twitter (averaging 150 tweets/month) and Facebook and created user-friendly infographics to summarize SC's weather events and monthly climate.

Information Services:

- The SCO averaged 18 monthly phone and email requests for climate data. The office provided this data to a variety of outlets, including judiciary institutions, the media, and several state as well as federal government agencies. The SCO conducted 32 media interviews.
- Staff assisted SCDNR Law Enforcement, SC Highway Patrol, and County Solicitor Offices with multiple watercraft, vehicle, and criminal investigations.
- The office issued weekly and annual summaries of the State's weather and climate in the *South Carolina Weekly Weather and Climate Report* and the *South Carolina Year in Review*. https://www.dnr.sc.gov/climate/sco/ClimateData/yearly/cli_sc2022review.pdf . Data from these summaries are also highlighted in the weekly USDA Crop Progress and Condition Reports https://www.nass.usda.gov/Statistics_by_State/South_Carolina/Publications/Crop_Progress_&_Condition/index.php .
- The Drought Response Program requires regular correspondence with 31 Drought Response Committee Members, four major power companies, and over 400 water utilities. Correspondence during drought events includes drought projections, official declarations, and suggested response. During 2022, the SC Drought Response Committee was convened eight times via teleconference.
- The SCSCO is the lead entity for South Carolina's input into the U.S. Drought Monitor (USDM). The office communicates on a weekly basis with state and federal entities including Clemson Extension, SC Department of Agriculture, NWS Offices, US Geological Survey, National Resources Conservation Service, Farm Service Agency, and USDM participants in NC and Georgia.
- The office created infographics to communicate weekly changes that were released via SCDNR social media and to the SC Drought Response Committee. The infographics are archived on the Office Drought Web Site. Example http://www.scdrought.com/images/topSeven/April_16_2022_to_April_22_2022_USDM_Infographic.pdf

Outreach

- The office in collaboration with the Carolinas Integrated Science and Assessments conducted three educational workshops about planning for future climate events and impacts (162 total participants).
- The SCO provided approximately 43 presentations to various governmental, private sector, and civic organizations. Staff were speakers or participants at many state and national organizations, conferences, and meetings. Included were the AMS Poster Session, National Weather Association's Annual Meeting, Interstate Council on Water Policy Annual Meeting, Edisto, Pee Dee and Broad River Basin Council Meetings, SC Hospital Association Leadership Summit, Cotton and Peanut Growers Annual Meeting, SCDNR Board Meetings, the Girl Scouts of America, Master Gardener Meetings, SC Adopt-a-Stream Key Note Speaker, Silver Jacket CRFSS, FEMA Region IV Climate Strategic Planning, NIDS Meetings and Webinars, Clemson University Emeritus College, NOAA Coastal Risk Workshop, SC Resilience Plan Advisory Committee Meetings, National Hurricane Conference, the SCEMD Dam Safety Workshop, SC Rural Water Summit, and the American Association of State Climatologists Annual Meeting.
- The office enhanced the State's drought and water resources communication by conducting seasonal weather and water webinars and issuing Monthly Water Summary Updates. The webinars provide an update on the State's water resources transitioning between seasons.
- Staff serve on various committees, such as the AMS Weatherband Committee, AMS Climate Services Committee, AASC Nominating Committee, Citadel's Climate Studies Advisory Board, SC Drought Response Committee, Catawba-Wateree Drought Management Group, Yadkin Pee Dee Drought Management Group, SCDNR Education Committee, SC Statewide Resilience Plan Advisory Committee and subcommittees, Clemson Weatherstring Committee, US Fish and Wildlife Civil Rights Review Committee, SC Water Chats Advisory Group

Research and Product Development:

- Since 2018, the SCO collaborated with DTN to create a precipitation alert and warning system (HydroMetPortal). The product launched in March 2021 and was funded through a FEMA Hazard Mitigation Grant. The SCSCO project will end in 2023.
- SCO developed three documents to highlight keystone climatological events of flooding, drought, and tornadoes recorded in South Carolina. Example report: <https://www.dnr.sc.gov/climate/sco/Publications/SCKeystoneFloodingEvents.pdf>
- SCO developed two documents; an extensive overview of the climate of SC and climate-related hazards and a booklet of climate data tools and descriptions for planners to reference as they look to add climate information into their planning processes. <https://www.dnr.sc.gov/climate/sco/Publications/SCClimateOverview.pdf>

- Staff provided guidance on the development of the first SC Statewide Resilience Plan that will be released in 2023.
- Staff provided guidance on the development of a statewide comprehensive survey of resilience planning <https://www.sceagrant.org/resilience-planning/>.

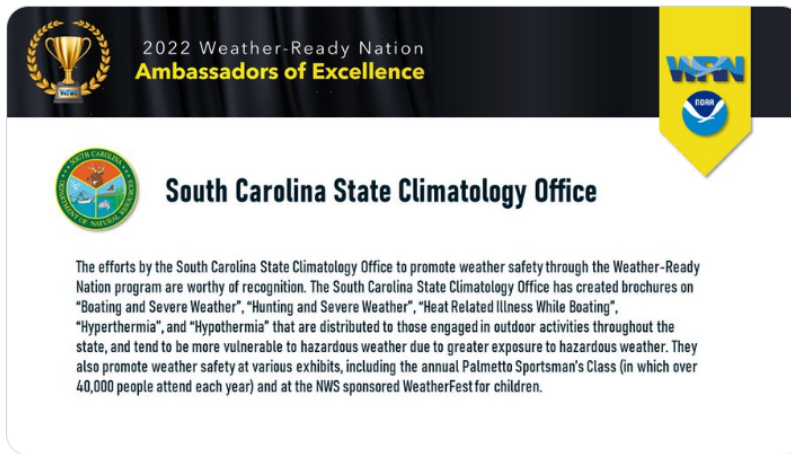
Monitoring and Impact Assessment:

- SCO serves as the State CoCoRaHS Coordinator. The office recruited 136 new CoCoRaHS volunteers throughout 2022 (79 are still active). South Carolina placed 3rd in the March Madness Recruitment Campaign with 51 new sign-ups.
- The office issued the annual CoCoRaHS Newsletter <https://www.dnr.sc.gov/climate/sco/Office/2022CoCoRaHsNewsletter.pdf>
- Of the active observers in SC, 73 observers have been with the program since 2008, 22 since 2012 (10-years) and 29 since 2017 (5-years). SC averages around 400 daily CoCoRaHS observations.
- The office distributed 6 complimentary rain gages to new CoCoRaHS observers through a Harry Hampton grant.
- The office secured a proclamation from the Governor's Office to recognize our state's citizen weather observers during the week of March 13 – 19, 2022.
- The SC drought portal is updated weekly with monitoring data and information.
- Staff closely monitored and answered questions on the anticipated impacts from 5 winter weather events, Tropical Storm Colin & Alex, as well as Hurricane Ian & Nicole. Staff were activated to the State Emergency Response Center to provide forecast support for Hurricane Ian's impacts to SC.
- As a member of the State's Emergency Operations Team, SCO staff participated in quarterly hurricane task force meetings, SCEMD State Emergency Response Team Hurricane Exercise, and the Governor's Hurricane Seminar.
- The office provided exercise weather scenario briefings on winter weather, severe weather and hurricanes for SC Emergency Management Division and SC Department of Public Safety.
- The office issued 1 weather alert for Tropical Storm Alex, 1 for Tropical Storm Colin, 8 for Hurricane Ian, and 9 for Hurricane Nicole. These were fulfilled via our email listserv.
- The SCO issued 14 winter weather alerts and 52 weekly updates.
- Customized forecasts were routinely issued for various SC organizations. Examples include the SCDNR Law Enforcement, Marine Resources Division and Archeologists, SC Sheriff's Association, SC Dept. of Public Safety, the SC Governor's Cup event, and the University of South Carolina
- The office issued Open-File Reports on Hurricane Ian, the April 5-6th tornado outbreak, the January 16th winter storm, and the January 21st winter storm.

<https://www.dnr.sc.gov/climate/sco/Publications/WinterStormOpenFileReport011622.pd>
https://www.dnr.sc.gov/climate/sco/Publications/storm_reports/WinterStorm2022-01-21.pdf
https://www.dnr.sc.gov/climate/sco/Publications/storm_reports/OFR-April-2022-Tornadoes.pdf
https://www.dnr.sc.gov/climate/sco/Publications/storm_reports/OFR-Hurricane-Ian.pdf

Other Highlights:

SCO was selected as one of the 2022 Weather-Ready Nation Ambassadors of Excellence - collaborating with SCDNR's hunter and boating education to create brochures on outdoor weather safety, helping SC citizens and tourists be prepared while enjoying boating, fishing, and hunting.



The graphic is a rectangular award certificate. At the top left is a gold trophy icon. To its right, the text reads "2022 Weather-Ready Nation Ambassadors of Excellence". At the top right is the Weather-Ready Nation (WRN) logo, which features a blue and yellow shield with a white wave and the letters "WRN" above it. Below the trophy icon is the South Carolina State Climatology Office logo, which is a circular seal with a landscape scene and the text "SOUTH CAROLINA STATE CLIMATOLOGY OFFICE". To the right of this logo is the text "South Carolina State Climatology Office". Below this, a paragraph of text describes the office's efforts in promoting weather safety through the WRN program, mentioning the creation of brochures on "Boating and Severe Weather", "Hunting and Severe Weather", "Heat Related Illness While Boating", "Hyperthermia", and "Hypothermia", and their distribution at various events like the Palmetto Sportsman's Class and WeatherFest.

**2022 Weather-Ready Nation
Ambassadors of Excellence**

South Carolina State Climatology Office

The efforts by the South Carolina State Climatology Office to promote weather safety through the Weather-Ready Nation program are worthy of recognition. The South Carolina State Climatology Office has created brochures on "Boating and Severe Weather", "Hunting and Severe Weather", "Heat Related Illness While Boating", "Hyperthermia", and "Hypothermia" that are distributed to those engaged in outdoor activities throughout the state, and tend to be more vulnerable to hazardous weather due to greater exposure to hazardous weather. They also promote weather safety at various exhibits, including the annual Palmetto Sportsman's Class (in which over 40,000 people attend each year) and at the NWS sponsored WeatherFest for children.

Office of the State Climatologist of Texas

ARSCO Annual Report for 2022

State Climatologist: John Nielsen-Gammon

Assistant State Climatologist: William Baule

Service Climatologist: Alison Tarter

Graduate Students: Savannah Jorgensen, Judith Dickey, Austin Buley

Student Assistants: Chris Larson, Hayden Dove, Virginia Elliott, Ashley Palm

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About Texas's State Climate Office

The Office of the State Climatologist (OSC) has been housed in the Department of Atmospheric Sciences at Texas A&M University since 1973. The current State Climatologist, John Nielsen-Gammon, was appointed by then-Governor George W. Bush in 2000. The mission of OSC is to help Texas and its residents make the best possible use of weather and climate information.

In 2021, Texas A&M University became the host of the Southern Regional Climate Center (SRCC), with John Nielsen-Gammon as Director. The colocation of the SRCC with the OSC has permitted Texas A&M to hire additional climate services personnel who divide their efforts between the SRCC and the OSC. This accounts for the increased number of names within the OSC sphere.

Communication Capabilities

The OSC maintains a web site (<http://climatexas.tamu.edu>) and has placeholder accounts for Facebook (ClimaTexas), and Twitter (@climatexas). The website and social media pages were created to provide a wide range of sources for information delivery.

Information Services, Products and Tools

The OSC does not generate climate data of its own. Instead, it serves as a clearinghouse for connecting climate data needs with climate resources. The OSC receives data requests via telephone and email.

Research, Projects and Publications

An important research theme within the OSC is extreme precipitation. A paper on observed extreme rainfall trends in the south and southeast United States (a combined effort of the OSC and SRCC) is presently under review:

Jorgensen, S., and **J. W. Nielsen-Gammon, 2023**: Observed extreme rainfall trends along the United States Gulf and southeastern coasts. *J. Hydromet.*, under revision.

The work represents Savannah Jorgensen's Master's Thesis of the same title, approved in May 2022. The OSC recently began a new project funded by the Texas Water Development Board to develop extreme rainfall grids for Texas, similar to what's known as NOAA Atlas 14, but taking trends in extreme precipitation into account. The OSC is also participating in a research project funded by the Texas General Land Office via the US Army Corps of Engineers to better characterize extreme storm precipitation distributions that lead to flooding within large river basins in Texas.

Another research theme developed in February 2021 with a major weather disaster in Texas due to extreme cold and winter precipitation. Master's student Judy Dickey is finishing her thesis on the subject. The State Climatologist instigated and contributed to a recent regionally-relevant paper examining the disruptive extent of the event and comparing it to other historical cold waves:

Bolinger, R. A., V. M. Brown, H. E. Attard, A. M. Bentley, C. M. Fuhrmann, K. L. Gleason, T. A. Joyner, B. D. Keim, A. Lewis, **J. W. Nielsen-Gammon**, C. J. Stiles, and W. Tollefson, 2022: An assessment of the extremes and impacts of the February 2021 South-Central U.S. Arctic

outbreak, and how climate services can help. *Weather and Climate Extremes*, doi:10.1016/j.wace.2022.100461.

A third research theme focuses on drought. Graduate student Libert Niyonkuru is investigating drivers of soil moisture trends in global climate models.

Other somewhat miscellaneous research involves interpretation of trends in global climate models, impacts of hot, dry, and windy days on winter wheat, and climate change effects on Hurricane Harvey:

Hausfather, Z., K. Marvel, G. Schmidt, **J. Nielsen-Gammon**, and M. Zelinka, 2022: Climate simulations: recognize the ‘hot model’ problem. *Nature*, 605, 26-29, doi:10.1038/d41586-022-01192-2.

Zhao, H., L. Zhang, M. B. Kirkham, S. M. Welch, **J. W. Nielsen-Gammon**, G. Bai, J. Luo, D. A. Andresen, C. W. Rice, N. Wan, R. P. Lollato, D. Zheng, P. H. Gowda, and X. Lin, 2022: U.S. hard winter wheat yield loss attributed to compound hot-dry-windy events. *Nature Communications*, 13, 7233, doi:10.1038/s41467-022-34947-6.

Li, X., D. Fu, **J. Nielsen-Gammon**, S. Gangrade, S.-C. Kao, P. Chang, M. Morales Hernández, N. Voisin, Z. Zhang, and H. Gao, 2023: Impacts of climate change on future hurricane induced rainfall and flooding in a coastal watershed: A case study on Hurricane Harvey. *J. Hydrol.*, 616, 128774, doi:10.1016/j.jydrol.2022.128774.

The OSC is writing a book chapter on climate change impacts on freshwater inflows to Texas bays and estuaries, as part of a larger coastal Texas book project funded by the Texas General Land Office.

The State Climatologist completed several years of service on the Prediction, Predictability, and Applications Interface Panel of the US CLIVAR Program as co-chair of the panel and a member of the Scientific Steering Committee.

Outreach and Education

The following outreach talks were given by the OSC in the year 2022.

Nielsen-Gammon, J. W., 2022: Texas Climate Trends and Drought. Bell County Water Conservation Symposium, Clearwater Groundwater Conservation District, Belton, TX.

Nielsen-Gammon, J. W., 2022: Texas Drought: Trends and Impacts. Water Environment Horizon Conference, Water Environment Association of Texas and Texas Association of Clean Water Agencies, Austin, TX.

Nielsen-Gammon, J. W., 2022: Global Climate Change: Some of It Is Basic Physics (and some not). 2022 Student Physics Society Distinguished Public Lecture in Physics, Texas Lutheran University, Seguin, TX.

Nielsen-Gammon, J. W., 2022: Texas Drought: Trends and Impacts. 2022 Annual Conference, Texas Economic Development Council, San Antonio, TX.

Nielsen-Gammon, J. W., 2022: TWCA Fall Conference, Texas Water Conservation Association, San Antonio, TX (panel discussion).

Nielsen-Gammon, J. W., 2022: Climate Change and Texas Extreme Rainfall. Monthly Meeting, North Texas Chapter of the American Meteorological Society/National Weather Association, Fort Worth, TX.

Nielsen-Gammon, J. W., 2022: Summer 2022: What Happened and Why. TMTuesdays, Texas Master Naturalist Program, Virtual.

Nielsen-Gammon, J. W., 2022: The Texas Megadrought. Southern Plains Drought Early Warning System Partners Meeting, National Integrated Drought Information System, Norman, OK.

Nielsen-Gammon, J. W., 2022: Extreme Precipitation. RCC-Marine West SOO In-Person Meeting 2022, National Weather Service, League City, TX.

Nielsen-Gammon, J. W., 2022: Climate Change Trends in Texas: Winter Weather, Drought, Heat, and/or Flood. FEMA 2022 Region 6 Mitigation Workshop, Federal Emergency Management Administration Region 6 Mitigation Division, Fort Worth, TX, Virtual.

Nielsen-Gammon, J. W., 2022: What Water Planners in Texas Need to Know About Climate (And I Wish I Could Tell You). CASE 2022 Conference, Capital Area Suburban Exchange, Montgomery, TX.

Nielsen-Gammon, J. W., 2022: What Water Planners in Texas Need to Know About Climate (And I Wish I Could Tell You). Managing Your Water System into the Future: Building Resilience to Handle the Next Major Challenge, Texas Training, Southwest Environmental Finance Center, University of New Mexico, Temple, TX.

Nielsen-Gammon, J. W., 2022: Climate Change and Texas Extreme Weather. Climate Change in San Antonio Webinar Series, League of Women Voters, San Antonio, Texas, Virtual.

Nielsen-Gammon, J. W., 2022: The Nature of Weather, Climate, and Water. Master Naturalist Training, Heartwood Chapter, Texas Master Naturalists, Huntsville, TX.

Nielsen-Gammon, J. W., 2022: Texas Drought Status. Texas Drought Status Webinar, National Integrated Drought Information System, Virtual.

Nielsen-Gammon, J. W., 2022: Weather and Climate Outlook for Texas Drinking Water. WaterCon 2022, Texas Rural Water Association, Round Rock, TX.

Nielsen-Gammon, J. W., 2022: What Water Planners in Texas Need to Know About Climate (And I Wish I Could Tell You). North Central Texas Council of Governments Monthly Meeting, Arlington, TX.

Nielsen-Gammon, J. W., 2022: Climate and Texas Water Resources. Master Naturalist Training, Gideon Lincecum Chapter, Texas Master Naturalists, Round Top, TX.

Nielsen-Gammon, J. W., 2022: Climate Change and Extreme Weather: Three Ways of Knowing. Central Texas Water Conservation Symposium, Central Texas Water Efficiency Network, Austin, TX.

Nielsen-Gammon, J. W., 2022: Cup Chat, Birding, Texas A&M Agrilife Extension, virtual (Q&A)

Nielsen-Gammon, J. W., 2022: Climate Change and Memorable Weather. Coastal Prairie Chapter, Texas Master Naturalists, virtual.

Additional outreach is conducted through press contacts. During 2022, the OSC broke its previous record by providing 163 press interviews, satisfying 15 information requests, participating in 10 press releases via Texas A&M University and Texas A&M AgriLife, writing Texas-wide and Brazos Valley-specific articles for the quarterly CoCoRaHS Texas newsletter, and writing one op-ed for the El Campo Herald

Monitoring and Impact Assessment

The State Climatologist is an appointed member of the Texas Drought Preparedness Council, a statewide interagency committee created by the Texas Legislature in 1998 to monitor drought conditions and coordinate drought mitigation activities.

The State Climatologist is also a member of the State Hazard Mitigation Team. Both committees are chaired by the Division of Emergency Management.

Beginning in 2012, the OSC has served as host and organizer for weekly Texas Drought Monitor Coordination Conference Calls. These calls, held every Tuesday afternoon at 1:00 PM CT, are attended by National Weather Service personnel, extension agents, agency representatives, and drought monitor authors. The State Climatologist prepares a draft of suggested changes to the Texas portion of the weekly US Drought Monitor, and those changes are then discussed and amended. A summary of final recommended changes is sent to the Drought Monitor author via the USDM listserv. As part of this effort, the OSC maintains the Texas Drought Coordination listserv, which has over 65 subscribers.

Wyoming State Climate Office

ARSCO Annual Report for 2022 by Tony Bergantino



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About the Wyoming State Climate Office

The Wyoming State Climate Office (SCO) is a part of the Wyoming Water Resources Data System (WRDS). Together these entities are the single largest providers of water- and climate-related data in the state. WRDS was established in 1966 and, in the following year the Wyoming Legislature authorized the Water Planning efforts with which WRDS became involved. More than a half century later, one of our primary functions continues to be to support the Wyoming Water Development Commission, including the State's Water Planning Program. Additionally, our mission has expanded, growing well beyond what it was in those early days.

The WRDS/SCO staff provides a variety of services, ranging from the development of enhanced drought-monitoring products to the online dissemination of water and climate data in raw (numbers) and enhanced forms (maps, charts, etc). WRDS and the SCO also support a wide

range of groups by assisting in the development of the State Water Plan and helping to coordinate climate- and hydrologic-monitoring efforts throughout Wyoming.

In April of 2022 operations resumed for the most part in-office. The process, started in 4th Quarter of 2021 to fill two positions continued into the first two quarters of 2022, finally resulting in a return to 2019 staffing levels.

Communication Capabilities

WRDS/SCO is housed on the University of Wyoming campus and this setting allowed us to take early advantage of the available high-speed network infrastructure through which we continue to serve our various products online. WRDS/SCO has had an online presence for over a quarter-century. Several servers support the operations and house the various websites and databases used by the office.

In 2022, one-third of the time was spent with day-to-day operations at our remote secondary sites. These sites have full high-speed connection capabilities, so work has continued without interruption. Our servers continue to operate in a lights-out fashion in the campus data center and were operational 24/7.

As the State Coordinator for CoCoRaHS (the Community, Collaborative, Rain, Hail, & Snow Network), we use Twitter as well as list-servs to communicate with the observers. The SCO, itself, has its own Twitter feed, and List-servs to spread information to interested parties in the state. Growth of subscribers has been slow but steady.

Information Services, Products and Tools

During 2022 WRDS/SCO still received and answered 60 traditional-style requests (up 21 from 2021). These “traditional” requests are those where an individual contacted us directly for information. The bulk of these are now by email with a lesser (though not insignificant) percentage being made by phone and even in-person. The active/direct requests that we still receive are usually for more in-depth or interpreted products or where an individual is looking for an explanation/interpretation or a custom product rather than just numbers.

These active or direct requests have generally declined since their peak in 1997 (there was about a 50% uptick compared to last year) while the passive type of data request (where the user chooses from products already online) continues to increase. This trend will likely continue as

more and more products are developed and placed online. In 2022 our website served almost 102,000 unique users and the number of pageviews was just under 350,000, representing 3.5% and 7.5% increases respectively over 2021.

In 2022 we have continued scanning historical documents related to Wyoming's water and climate resources making them available through our Library website.

Research, Projects, and Publications

We continue making data available through our websites and are adding new data as needs arise and ideas strike. During 2022 we added volumetric snow water equivalent data/charts for each of Wyoming's 19 basins to our website and will be building upon that to help with water supply forecasting.

WRDS/SCO is also taking part in WY-ACT, a \$20 million National Science Foundation grant given to the University of Wyoming to work with Wyoming communities to deal with changes and variability of water availability.

Outreach and Education

Covid changed outreach by allowing a wider range of audiences. While many talks and presentations have been delivered in person, the ability to present remotely has allowed us to speak to groups at venues we would not normally have been able to attend.

There was a total of 20 talks/presentations made during 2022 to various groups including a monthly public webinar presented detailing conditions and outlooks.

Interviews were given to nine media outlets on topics including flooding, snowpack, drought, and wildfires.

In the process of locating sites for additional climate monitoring stations (See Monitoring and Impact Assessment below), we have worked with local Conservation Districts and County Farm Service Agencies to identify landowners willing to host stations. This collaboration has given us the opportunity to establish relationships with these offices and has resulted in being asked to give presentations to their constituents.

The WRDS/SCO continues to work with its funding agency, the Wyoming Water Development Office, and the State Engineer's Office to support the River Basin Planning in the state. This effort includes stakeholder update meetings around the state and affords us the opportunity to, not only present information on our portions of planning activities, but also to detail the operations of the Climate Office in general to make people more aware of our functions and capabilities.

Monitoring and Impact Assessment

The WRDS/SCO, continues to maintain local climate and hydrological stations for early-warning of potential flash flooding. We are also working with State, University, and Federal partners who are maintaining stations and are retrieving and disseminating data from those stations for them as part of the Wyoming Mesonet. In 2022, additional soil moisture probes provided to the State Engineer's Office were installed on their stations. Serving as State Coordinator for CoCoRaHS, that program has been a large part of our monitoring efforts as we continue to build out the Wyoming observer base.

The office is also actively involved in the Drought Monitor and trying to get more local entities involved in monitoring efforts to provide local feedback. Numerous presentations were given throughout the year to various groups to stress the importance of condition monitoring and to show people how they can help whether by collecting precipitation through CoCoRaHS or making condition reports through CMOR and/or CoCoRaHS.

WRDS/SCO is a part of the Upper Missouri River Basin Snowpack and Soil Moisture Monitoring Program. This program is an outgrowth of the 2011 floods along the Missouri River and a call for additional monitoring to assist with spring run-off forecasts. Five stations were installed during 2022 and data are being served through our web server.

The WRDS/SCO takes part in the National Mesonet Program and provides data from select stations in the Wyoming Mesonet.

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Climatologist / Director

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