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Environment Subcommittee Hearing - Reauthorizing the Weather Act: Users of Weather Data and Areas for Improvement by Sector

Chairman Miller, Ranking Member Ross, and members of the subcommittee. It is my honor to be here with you today, and thank you for a chance to testify about the need for robust weather and climate data; outline how we at the State Climate Office of North Carolina interface with NOAA weather and climate services; and provide some examples of how states like North Carolina help to fill critical gaps in NOAA's weather and climate data and research.

My name is Dr. Kathie Dello. I am the Director of the State Climate Office of North Carolina and serve as our State Climatologist. Our office is located in North Carolina's capital city, Raleigh, at North Carolina State University.

The need for weather and climate services in North Carolina

Let me share a community story with you. You've likely seen videos of houses falling into the ocean on the Outer Banks of North Carolina. However, you may be unfamiliar with the area known as Down East, North Carolina. It is a coastal community of 13 unincorporated villages with populations of less than 1,000 that are located just inside the Outer Banks area near Cape Lookout lighthouse. The population living in this community is aging, and most of these families have lived in Down East for generations. This community has seen the impacts of flooding firsthand -- from big events like Hurricane Florence, to daily nuisance floods that interrupt their lives in countless ways. People in these areas need climate data to help them understand how high to raise houses, business, schools and churches; channels to communicate these data to community members who are grappling with other stressors; and daily tidal flooding data to learn when roads are impassable. These flooding events are more than short-term inconveniences, they threaten public safety and health. Two-lane roads are often flooded and no shoulders exist in many places. Highway 70, a federal thoroughfare, is the only public access corridor available to these residents. The one hospital in the county is located in Morehead City, 52 miles away from the residents in Cedar Island. Retreat is not an option for Down East; this community lives with the water. This community needs data to inform solutions, and they need to know how to access funding for these solutions.

The need for such climate services in our state and our southeast region is clear. I have dozens of other stories from other communities that face challenges similar to Down East.

North Carolina is getting hotter, wetter, and more humid. Flood risks are prevalent statewide. We are approaching the five-year anniversary of Hurricane Florence, a Category 1 hurricane that caused unprecedented damage in eastern North Carolina. Florence was a generational storm that turned portions of Interstate 40 into a river and cut most of North Carolina off from the rest of the country. Storm-related flooding isn't contained to the coastal plain. Two years ago, Tropical Storm Fred caused catastrophic flooding in the North Carolina mountains, where valleys shaped like egg cartons are magnets for fast-flowing water. Warming nighttime temperatures threaten the development of crops such as berries and stone fruits. Agriculture is the cornerstone of North Carolina's economy – we sent the Capitol its christmas tree last year and we're among the top christmas tree producers nationwide. Hot Carolina days, increasingly warm overnights, and increased humidity present a public health risk that impacts everything;high school football; the workplace safety of rural farmworkers; low-income communities' and impact the health of pregnant women. Five years after Florence, you'll be hard pressed to find someone in North Carolina who does not acknowledge that the state's climate is changing. Our residents need quality weather and climate data coupled with solutions for their communities to truly thrive.

North Carolinians have been clear about their weather and climate data and research needs. Citizens need locally relevant, high-quality data that is actionable and that can inform solutions. Residents facing rising sea levels and more frequent flooding hazards need to know how to access the funding to implement solutions. As one of the most densely rural states in the country that is also rapidly urbanizing, North Carolina has unique challenges when it comes to adapting and responding to climate change.

The State Climate Office of North Carolina

The State Climate Office of North Carolina is a University of North Carolina System Public Service Center dedicated to serving the needs of North Carolinians by translating climate information into useful and usable knowledge, and bridging the gap between scientists, decision-makers, and community members. We are one of the largest and most productive state climate offices in the country. We have a full-time staff of 10, and numerous graduate and undergraduate students. We work with faculty across the UNC System, leveraging research and disseminating it across the state. We have strong ties with NC Cooperative Extension, including sharing a position in our office to interface with our state's county extension agents. North Carolina's county extension agents are located in every county in North Carolina and interface directly with the state's agriculture and forestry producers.

We work closely with other local, county and state agencies. The State Climate office runs the North Carolina ECONet, or Mesonet, a 44-site research-grade weather observing network sending nearly 1.5 million observations back to Raleigh each day.

Additionally, the State Climate Office enjoys a longstanding and fruitful relationship with NOAA. We are co-located with the National Weather Service (NWS) on North Carolina State University's Centennial Campus in Raleigh. This allows for collaboration, connection and the facilitation of data transfer to communities. We especially partner closely with the NWS on drought monitoring activities in the state. We are also located in the same state as NOAA's National Centers for Environmental Information in Asheville and have worked with the staff there to use their high-quality daily climate observations to help contextualize some of our work. I have two cooperative agreements with NOAA's Office of Atmospheric Research's Climate Program Office, including the aforementioned CAP/RISA. We have a contract with the National Mesonet Program through the National Weather Service. Our staff have participated in National Integrated Drought Information System activities, including helping to disseminate effective communications templates to other states for their use. And finally, in 2021, we were one of the lead organizations on the NOAA/National Integrated Heat Health Information System Urban Heat Mapping Campaigns in Raleigh and Durham, NC. These relationships bolster the capacity of the State Climate Office and the CAP, but also help NOAA reach a broader constituency in North Carolina.

Our recent external five-year review in February of 2023 noted that, "as an agency serving the people and government of North Carolina, the State Climate Office has all the hallmarks of a 'best in class' climate services organization, ranking among the top state climatologist offices in the nation. The staff is passionate and knowledgeable, excelling at education and outreach, climate and weather monitoring, and providing valuable knowledge and services to other state agencies and the North Carolina public. During the review, stakeholders from state universities and agencies highlighted the significant value provided by the State Climate Office, including data, summary reports, student mentoring and general operational advice."

The role of State Climate Offices and CAP/RISAs

State Climate Offices and CAP/RISAs play an integral role as the "boots on the ground" for NOAA and other federal agencies in the states, in developing and cultivating community partnerships, and filling in the gaps in critical climate data. Our CAP/RISA is targeting the communities that are hit first and worst by climate change. In North Carolina, having the two entities co-located has provided an advantage. We are able to understand where there are critical data gaps and leverage the data and resources of the State Climate Office. My

co-director, Dr. Jennifer Runkle, is co-located at NOAA's National Center for Environmental Information, and is also able to uniquely identify needs and pressing opportunities. With a strong foundation of leveraged climate data, research, and NOAA resources, we are able to seek out opportunities to work with communities on solutions and planning. While we are a newer CAP/RISA, only starting in late 2021, we have made significant progress in furthering community climate resilience. We are working with local public health departments, city and regional planners, and community organizations to help them respond to the needs of their local residents.

A few examples of how our CAP/RISA is addressing community weather and climate data needs:

One of our CAP/RISA investigators, Dr. Miyuki Hino, along with her colleagues at UNC Chapel Hill and NC State University, have developed low-cost, open-source sensors to detect "sunny-day" or tidal flooding in Coastal North Carolina. These sensors have filled in critical gaps in NOAA data. They find that coastal flooding is happening more often than past studies have shown, and projections of future coastal flooding are likely underestimated. In Beaufort, NC, they documented 24 floods (standing water on road) in five months; in comparison, NOAA would have reported four events and NWS would have reported eight over the same time period. Twenty-five percent of those events were due to a combination of rain and tide, which NOAA tide gauges are not designed to capture. Dr. Hino and her team are working with coastal communities to incorporate these data into planning and solutions.

Our Carolinas CAP/RISA team is working closely with the Eastern Band of Cherokee Indians in Western North Carolina and the US Department of Interior Southeast Climate Adaptation Science Center to create a climate action plan for the next seven generations. In our conversations with the tribe, the need for high-quality weather data of their own was identified in early conversations. In response to that needs assessment, the State Climate Office will be installing an "ECONet Extended" station in Cherokee, co-located with air quality monitoring equipment. These data sources will aid in the tribe's air quality monitoring and communications efforts, and also give them crucial data and information that they need to apply for external funding. We are committed to providing communities with resources through our CAP/RISA, and this is one way we can give back.

In Raleigh and Durham, our CAP/RISA team is focused on understanding compounding hazards. We are taking the Urban Heat Island mapping data from 2021, other sensors including the North Carolina ECONet, and local observations of flooding and heat using other local sources (e.g., street cameras, kestrels, flood activation signs) to use machine learning approaches to understanding compounding heat and flood hazards. We are

assessing when and where extreme heat and flood have sequentially occurred, evaluating whether the probability of their co-occurrence has changed over recent decades, and working with community partnerships to inform adaptation and mitigation efforts.

These three examples demonstrate where local research, partnerships and understanding have filled in gaps in NOAA's data at the community level, and where CAP/RISA capacity helped to connect data to solutions.

Service to the State of North Carolina

A central component of the State Climate Office's mission is its commitment to serving the State of North Carolina, which is a key consumer of our research, outreach, and decision-support activities. This effort by the Center creates efficiencies, saves the state significant time and money and adds valuable climate expertise capacity that state entities do not possess in-house. A few examples of the State Climate Office's services:

Cardinal and Station Scout Data Retrieval System

When I assumed the directorship in 2019, a top priority was to eliminate barriers to data access for communities, including offering all publicly funded data free of charge. In partnership with NC Cooperative Extension, the State Climate Office custom-built Cardinal and Station Scout tool, released in Spring 2021, puts the State Climate Office's 145 terabytes of publicly-funded climate data, including NOAA data, in the hands of all North Carolinians. This powerful and new user-friendly tool enables users to download, plot and explore North Carolina's climate and weather data without prior programming knowledge. Cardinal was developed in-house by Center staff, and the State Climate Office refines the tool quickly and often based on user requests. Prior to 2021, clients would have to request climate data manually by completing an electronic form or via email and, on average, each data request would take about 20 minutes of staff or student time. The State Climate Office charged $60/hr for large requests. With the development of Cardinal, the State Climate Office saved about 200 person days per year of employees' time while completing requests free of charge, and creating immense value to the state.

Multi-sensor Precipitation Estimate (MPE) Tool with the North Carolina Department of Transportation (NCDOT)

The State Climate Office created and upgraded the MPE tool in response to a contract with the NCDOT. The tool provides rainfall monitoring and alert services to DOT employees and their contractual partners, based on weather-radar-based rainfall estimates and gauge data from NOAA and the NC State Climate Office. Users can view and explore rainfall over

different time periods across North Carolina using the MPE map. The North Carolina State Climate Office developed a system for users to set their own location sites across the state to subscribe to near-real-time alerts based on user-defined rainfall thresholds and time periods. Previously, contractors would have to check rain gauges manually for state and federal water quality monitoring compliance. It is estimated that this tool saves NCDOT about $3 million each year. The State Climate Office collaborates with NCDOT on other efforts, including updating intensity-duration-frequency precipitation curves and other research topics. This collaborative effort also allows for informal conversations; SCO staff are able to brief NCDOT staff and leadership on emerging climate trends and issues.

These are just two examples of the State Climate Office's numerous state collaborations. We also work closely with NC Department of Health and Human Services, NC Department of Agriculture and Consumer Services, the NC Department of Environmental Quality and other state agencies to build custom tools, participate in outreach events and do original research.

North Carolina ECONet (Mesonet)

Perhaps the most visible footprint of the State Climate Office is the NC ECONet, North Carolina's Mesonet. This research-grade environment and climate observing network measures 16 environmental variables in one-minute intervals. Some of these stations date back to the late 1970s, and new stations are added to fill in critical gaps (e.g., Nags Head/Jockey's Ridge State Park on the Outer Banks) or as an opportunity to collaborate with another sector or entity (e.g., UNC Asheville and academic training). 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. These thermometers allow us to calculate wet bulb globe temperature, or a more precise measure of heat stress on the human body. 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. During Hurricane Florence, National Weather Service forecasters were able to rely on our data to give them real-time data on the storm. Our stations run on solar power and were able to stay powered to provide life-saving information and data.

Staff use ECONet data to create custom web tools and dashboards for agricultural producers. One such tool issues alerts for the safe spraying of herbicides based on atmospheric conditions; we look for the presence of an inversion using wind and temperature data. We work with NC State's Plant Pathology, Crop Science and Entomology extension experts to issue alerts on the potential for peanut disease and to advise growers on the best times to apply fungicides. We have created custom tools for the North Carolina

Corn Growers Association and to help producers explore accumulated growing degree days. These tools are often developed using NC ECONet data, and NOAA data in some cases – including Climate Prediction Center seasonal outlooks.

ECONet is funded in part by NOAA's National Mesonet Program, and with additional support from NC State University and some individual donors. The ECONet is also a catalyst for workforce development. ECONet staff are cross-trained in station maintenance, tool development, GIS and coding in entry-level positions. We are able to offer internships to work with the ECONet team to NC State University students. The ECONet is at the center of State Climate Office activities, and is integrated into our tools, our outreach, and our training and workforce development opportunities. Growth of our network would allow us to offer more opportunities to students and early career professionals.

Despite the overwhelming demonstrated need for more, actionable, localized, high-quality data in communities, there are serious limitations. The goal is to have at least one ECONet station in each of the 100 counties. The demand is there, and the need is too. Our stations are located in places where there isn't a NOAA weather or climate station. Dewpoint, black globe, wind and/or humidity data are lacking in some of these other networks, which are critical for agriculture and public health. These data sources fill in crucial gaps in our understanding of North Carolina's environment. Furthermore, as known officials in our state, using the trusted NC State University Extension name and our land-grant designation, we are able to identify key partners and end-users of this data in a way that a federal agency like NOAA cannot. Our office also serves as a translator of these massive data sources and are trusted messengers in and around the southeast US.

One major challenge is adequate funding. The State Climate Offices receive some funding from the National Mesonet Program via NOAA , it pales in comparison to what states like North Carolina need to run a fully-functioning, statewide mesonet. Despite the enormous demonstrated value and cost-savings provided by this life and property–saving data, only $92,655 was sent to North Carolina in the last term of the National Mesonet Program contract for a period of 10 months ending in April 2023. This current contract, totaling $328,083 for the three years, has lapsed. We have been promised another five-month increment/extension, but NC State is having to supplement the funding until we get it. In the meantime, we are still responsible for meeting our data availability targets during this lapse in funding. This is a huge burden for states without a safety net like the bridge funding we're receiving. Furthermore, these short-term extensions are a significant additional administrative burden on the staff of the State Climate Office staff, NC State contracts and grants office and on NOAA contractor program staff. The short-term contracts reduce our ability to focus on the task at hand, which is providing high-quality, real-time research grade weather data to the state of North Carolina. Additionally, these short-term,

low-value contracts prevent us from expansion. With unstable funding mechanisms, we are reluctant to expand into areas that may need these data streams. There is room for NOAA and the National Mesonet Program to make a solid investment in state mesonet data, with significant benefit to myriad NOAA programs, not just the National Weather Service. We have demonstrated the need for local-scale climate and weather data through our CAP/RISA work. Put simply, the investment in our state's ECONet/Mesonet by the National Mesonet Program is far below what it should be given the value of the network and data to NOAA and the State of North Carolina.

We know that what we have in North Carolina is special and we are fortunate. The North Carolina State Climate Office provides enormous value to the State of North Carolina through community and state agency partnerships, and a long legacy of trust and delivery of climate services across all 100 counties. The addition of the CAP/RISA at NC State has allowed us to better connect this data and knowledge with communities to further the development of solutions. The support of NC State University coupled with the university's land grant mission allow for us to truly serve the public. Co-location and cooperation with NOAA entities allow us to leverage NOAA data, people and products for use in our communities. Partnerships with other federal climate efforts like the Southeast Climate Adaptation Science Center ensure that we're using taxpayer dollars to their fullest and not duplicating efforts. We have smart, savvy engaged community stakeholders and some of the nation's top research universities. In North Carolina, we come together to solve the state's biggest challenges – as evidenced by a $25 million bipartisan effort to create a flood modeling blueprint for the state – we can put political differences aside to ensure that our communities survive and thrive in the face of climate change.

Not all states are as data-rich or as aligned as North Carolina. Demand still outweighs capacity in North Carolina and the challenges are greater in other states. Despite considerable leverage and careful coordination, NOAA weather and climate data efforts, while admirable, are often uncoordinated and are siloed in line offices, resulting in duplication of tasks and effort. Despite frequent engagements from NOAA entities on climate and weather in communities, NOAA has completely failed to respond to requests in some instances. One example of the most requested and the most basic weather and climate data needs of the communities has been the extremely delayed update to historical precipitation curves (Atlas-14) that are used extensively in planning and projects. I know that there has been movement and funding to deliver these products, but we need urgent action to complete this task. The State Climate Office has worked with NOAA to ensure that they have all the relevant data for North Carolina. But it is too little, too late. These historical updates will unfortunately be outdated when they arrive in Atlas 15 in 2027 and are coupled with future projections. In North Carolina, we could not wait. We have updated these precipitation frequency curves to include climate projections, a project that is a

collaborative effort between NC State, NC Department of Transportation, and the North Carolina Office of Resiliency and Recovery.

It is difficult for us in positions like mine to recommend that our communities invest in climate engagement efforts that may not result in tangible data and products. And while efforts like the urban heat mapping projects generate a lot of buzz, useful data and products – they represent an enormous time commitment and we cannot sustain the massive community weather and climate data needs on the backs of citizen volunteers. With the reauthorization of the Weather Act, we hope NOAA can do the following:

- Step up as the authoritative weather and climate data source for the nation by coordinating climate efforts across line offices and being responsive to state and community weather and climate needs.
- Increase funding to state mesonets through the National Mesonet Program for critical life and property saving data.
- Continuing to fund the CAP/RISA program at current or higher levels. The CAP/RISAs are an important mechanism that communities can use to turn climate data into solutions.
- Ensure equitable access to publicly-funded data for all, including translational services.
- Funding positions in state offices like mine to ensure that we're making forward progress to maintain the safety of life and property in a changing climate and not continuing to ask communities what they need and not delivering in one-off engagements.
- Scale and transfer nationwide some of the fairly low-cost research and monitoring, like the sunny-day flooding monitors and urban heat island monitoring using micronets.
- Ensure that vulnerable, rural, and remotely located Down Easts of the country get the same amount of attention as the larger, more-resourced cities. We are always thinking of the next Florence, the next Fred, the next Floyd.

Short Biography

I have been in the position of the State Climatologist for North Carolina for more than four years. Before coming to North Carolina, I spent nearly a decade as the Associate Director of the Oregon Climate Change Research Institute at Oregon State University. Additionally, since late 2021 I have co-directed the NOAA Climate Adaptation Partnership (CAP, formerly RISA) for the Carolinas. I was also involved in the former Climate Adaptation Partnership/RISA in the Pacific Northwest, the Climate Impacts Research Consortium, or CIRC.

I have nearly 15 years of experience in state-level climate service boundary organizations that span weather and climate data and science and decision-making. I led Oregon's first climate assessment report in 2010, participated in two others, and was an author on North Carolina's first climate assessment report in 2020. I am an author on the Southeast Chapter of the 5th National Climate Assessment, due out this fall. I have worked extensively with state, local, and county governments; state agencies; and on federal research grants. I have participated in state-level climate adaptation efforts in New York, Oregon, and North Carolina.

I thank you for the opportunity to testify today and I look forward to answering any questions you may have for me.