



NORTH CAROLINA CLIMATE OFFICE

2013-2014 ANNUAL REPORT

June 16, 2014

The State Climate Office of North Carolina (SCO) serves as the primary scientific extension resource for weather and climate science focused on North Carolina. Founded in 1976 and chartered as a Public Service Center by the UNC Board of Governors in 1998, the SCO focuses on service to public and private sectors of North Carolina through climate science extension, research, and education.

Dr. Ryan Boyles
Director and State Climatologist

Mr. Ameenulla Syed
Associate Director and ECONet Manager

Mr. Aaron Sims
Associate State Climatologist

Ms. Ashley Hiatt
Environmental Meteorologist

Mr. Sean Heuser
Instrumentation Meteorologist

Mr. John McGuire
Environmental Meteorologist & Developer

Ms. Heather Dinon Aldridge
Applied Climatologist

Ms. Rebecca Cumbie
Extension Climatologist

Mr. Greg Deleruyelle
Administrative Support Specialist

Mr. Nathan Parker
Technology Support Specialist

Mr. Corey Davis
Applied Climatologist

Mr. Jim Epps
Coastal Carolina University / Meso US Partner

Ms. Adrienne Wootten, Graduate Assistant

Ms. Geneva Ely, Undergraduate Assistant

Mr. Colin Loftin, Undergraduate Assistant

Ms. Melissa Mainhart, Undergraduate Assistant

Mr. Andrew Martin, Undergraduate Assistant

Mr. James McClellan, Undergraduate Assistant

Ms. Jessica Miller, Undergraduate Assistant

Ms. Madeline Pope, Undergraduate Assistant

Mr. Samuel Roback, Undergraduate Assistant

Ms. Emma Scott, Undergraduate Assistant

Mr. Joseph Taylor, Undergraduate Assistant

Extension Advisory Board

Mr. Greg Fishel, Chair, WRAL-TV

Mr. John Dorman, NC Emergency Management

Mr. Steve Harned, Atlantic States Weather

Mr. Bill Holman, The Conservation Fund, NC

Dr. Walt Robinson, NCSU MEAS

Mr. Tommy Shingleton, Shingleton Farms

Dr. David Monks, NCSU Agricultural Research

Table of Contents

Executive Summary 2

Mission..... 3

Extension 4

Applied Research..... 16

Educational Outreach 20

Appendix A: Climate Services by Client Sector 25

Appendix B: Simplified Budget..... 27

Appendix C: Impact Statement 28

Staff and Students, May 2014



Back Row: Ashley Hiatt, Greg Deleruyelle, Andrew Martin, Heather Dinon Aldridge, Aaron Sims, Jim Epps
Middle Row: Sam Roback, Colin Loftin, John McGuire, Nathan Parker, Adrienne Wootten, Emma Scott, Jessica Miller, Ryan Boyles
Front Row: Sean Heuser, Corey Davis, Madeline Pope, Rebecca Cumbie, Geneva Ely, Ameenulla Syed
Not Pictured: Melissa Mainhart

Executive Summary

In the Academic Year 2013-2014, the State Climate Office continued its efforts to deliver climate services to the state of North Carolina through extension, research, and education programs.

Extension efforts focus on providing climate services through direct contact, online databases and analysis tools, environmental monitoring, and routine climate summaries. We partner closely with other scientists in agriculture, natural resources, public health, and water resource management to develop and deliver sector-focused climate services. We maintain an extensive Environment and Climate Observing Network (ECONet) and support regional climate services in partnership with the NOAA Southeast Regional Climate Center.

Direct requests for services have had a slight increase (~ 1%) in the past year, online visits increased by nearly 67%, resulting in a more than doubling of web traffic in the past two years. Our climate database also continues to see heavy traffic, with 2.3TB of internal database transfers each month, about one billion data records selected, updated, or inserted each month, and more than 2.3 million queries made over the past year. Maintaining and expanding the NC ECONet is an ongoing challenge, but these observations are unique and provide a highly valued service for state, local, and federal agencies. In the past year, we continued to deliver agriculture disease and forecast services, and provide service to the forestry and natural resource sectors. We have also continued to engage and serve the public health community in North Carolina.

Research efforts in the SCO are connected to our unique data resources and established relationships with other disciplinary scientists. In the past year, we continued work to improve our ability to model and estimate climate conditions for times and locations where observations are not available, including a new emphasis on humidity and leaf wetness to support agricultural pest management. We also continue to develop methods for improved drought monitoring, precipitation monitoring, and climate forecasting both with partners at NCSU and with research collaborators across the nation. In 2013-14, we enhanced our research collaborations with ecosystem and biological scientists through workshops, climate modeling, and research publications focused on climate impacts to natural and managed landscapes.

As North Carolina's primary statewide resource for informal climate education, outreach programming is a substantial focus for SCO staff and students with more than 40,000 direct educational outreach contact hours. We provide direct outreach for dozens of school and community groups, participate in large science education events such as StormFest and NC Science Festival, and push a range climate news and information to the public via our blog and social media. We also hosted our 11th year with student interns from Centennial Campus Magnet Middle School and engaged NC teachers through the CoCoRaHS grassroots rainfall network.

These activities were supported by funding from College of Sciences, the NC Agriculture Research Service, and external contracts and grants.

MISSION

As approved by the UNC Board of Governors, October 8, 1998

Extension

- Provide the most accurate climate information to the citizens of North Carolina.
- Assist North Carolina state agencies in climate-environment interaction issues and related applications.
- Establish, operate, and maintain an extensive meteorological network across North Carolina and archive and disseminate this data to the public in a timely fashion.
- Assist other extension scientists by integrating climate information into applications such as agricultural and environmental models.
- Increase public awareness of variations in North Carolina climate and environment.

Research

- Study North Carolina's climate and its interaction with the environment.
- Investigate the effects of climatic variations on agriculture, air pollution, and natural resources and develop forecasts that assist in resource management.

Education

- Interact with K-12, community college teachers and students, and with other community organizations on different aspects of NC climate and environment.

CLIMATE EXTENSION

Extension efforts focus on providing climate services through direct contact, online databases and analysis tools, environmental monitoring, and routine climate summaries. We partner closely with other scientists in agriculture, natural resources, public health, and water resource management to develop and deliver sector-focused climate services. We maintain an extensive Environment and Climate Observing Network (ECONet) and support regional climate services in partnership with the NOAA Southeast Regional Climate Center.

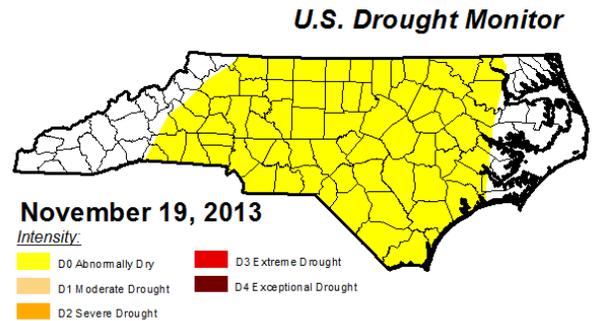
Direct requests for services have had a slight increase (~ 1%) in the past year, online visits increased by nearly 67%, resulting in a more than doubling of web traffic in the past two years. Our climate database also continues to see heavy traffic, with 2.3TB of internal database transfers each month, about one billion data records selected, updated, or inserted each month, and more than 2.3 million queries made over the past year. Maintaining and expanding the NC ECONet is an ongoing challenge, but these observations are unique and provide a highly valued service for state, local, and federal agencies. In the past year, we continued to deliver agriculture disease and forecast services, and provide service to the forestry and natural resource sectors. We have also continued to engage and serve the public health community in North Carolina.

Climate Information Services: *The State Climate Office provides many climate science services to clients and partners. Climate Services is a broad concept, but fundamentally involves interaction between a client who needs climate information and SCO scientists who are experts in climate data and climate science. Many users are not sure what data or information is best for their needs, and often need guidance on how to properly use and interpret climate information. SCO staff and students interact directly with users to ensure responsive and reliable climate information services.*

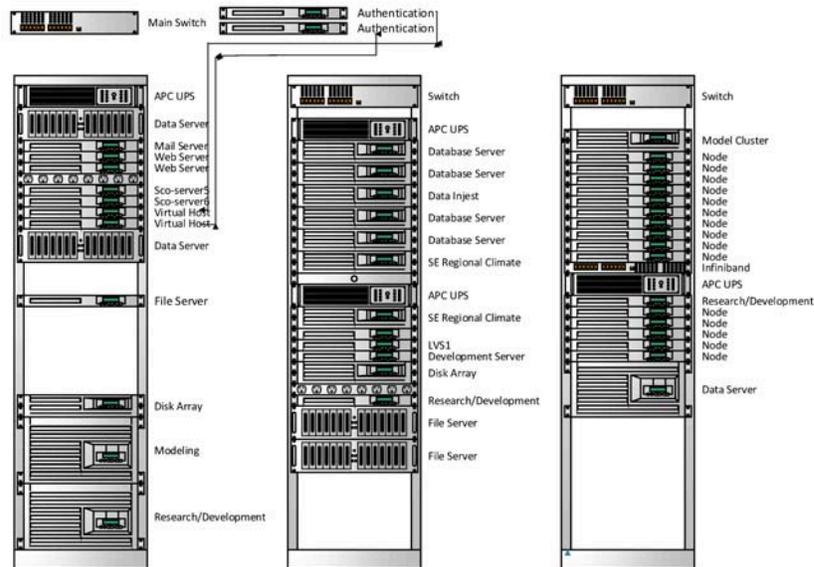
Requests for Services: Direct requests from clients via email and phone during 2013-2014 resulted in a slight increase (1%) in time spent directly responding to requests for services from clients as compared with the previous year. As with most years, a large percentage of time was devoted to supporting educational requests (64%), while remaining effort went largely to support government (16%) and private industry (14%). Formal public interest requests accounted for 6% of effort. A detailed breakdown of request-driven climate services is provided in Appendix A. While direct requests for information have only slightly increased over the past year, usage of online climate data resources continues to grow rapidly with 67% increase in website visits. *Team: All staff and students*

Monthly climate summaries: Climate summary reports are prepared each month to review monthly and seasonal climate patterns, their causes, and impacts to agriculture and water resources in NC. These are distributed via our blog service (<http://www.nc-climate.ncsu.edu/blog/>), reports to NOAA through the Southeast Regional Climate Center (SERCC), the Southeast Climate Consortium (SECC), and a Twitter social media feed. Climate summaries during this period had 6,698 views. *Team: Corey Davis, Heather Dinon Aldridge, Ashley Hiatt, Ryan Boyles*

Drought Monitoring and Response: The SCO is a member of the NC Drought Management Advisory Committee, participating in weekly drought monitoring conference calls and providing public presentations on drought in NC. During the weekly calls, the SCO regularly provides information on recent precipitation placed in historical context as well as the current level of dryness indicated by custom maps of drought indices calculated by the SCO. The SCO has provided routine updates on drought conditions and impacts through the Drought Management Advisory Committee, monthly climate summaries and blog posts, and interviews for print and broadcast news media. Over the past year, NC has largely been spared from drought, with the most severe conditions in the winter to early spring seasons, followed by some abnormal dryness late fall into early winter. *Team: Rebecca Cumbie, Ryan Boyles*



Environmental Data and Modeling: The SCO continues to produce routine experimental numerical weather forecast guidance using the Weather Research & Forecasting model. Timely production of model forecasts and simulations for analysis and distribution to key partners and stakeholders requires dedicated high-performance computing with low-latency network interconnects.



Schematic of SCO computing infrastructure

These simulations are available for use by the public, and are distributed to partners in NC Department of Environment and Natural Resources (NCDENR) and National Weather Service (NWS). Moreover, these datasets provide the critical inputs to a series of agricultural products, including routine peanut disease guidance, disease forecasts for cucurbits (cucumbers, squash, melons, etc), heat and chill forecasts for small fruits, and efforts with smoke management. We are currently producing 66 GB of raw model data per day. Additional data processing and incorporation into applications and tools generates an additional 10 GB of data per day. Presently, we are archiving and serving up over 25TB of gridded data from various sources, which is three times the amount as last year. These datasets are a key expansion area for the SCO and provide unique insight to weather and climate information. Data storage capacity is key to retaining valuable gridded datasets and newly obtained enterprise data servers offer seamless expansion capabilities for growth in this area. Proper data management is critical to maximize dataset storage, availability, and accessibility for end users. *Team: Aaron Sims, John McGuire, Nathan Parker*

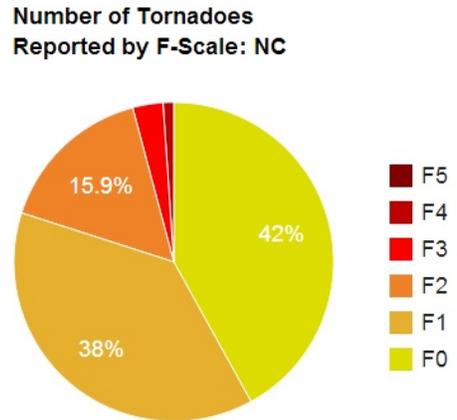
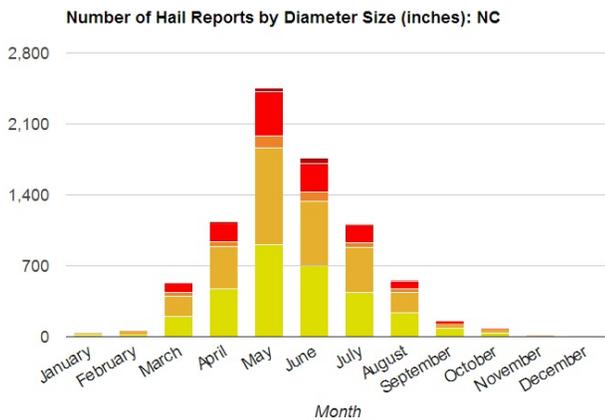
Website The SCO website is often the first point of contact with clients who need climate information. Effort over the past several years has been focused on linking web products and tools to the climate observation database to provide products and services that are dynamically updated.

Usage: The number of website visits (sessions) increased by 66.6% (869,237) over the previous year (521,887). Of these visits, 78.7% of these were from new visitors (684,435), an increase of 76% over the previous year (388,866). *Team: John McGuire, Ashley Hiatt, Aaron Sims*



- January 6th, 2014 brought the most web visits in a single day (6,228)
- 28.6% of all visits came from North Carolina
- 68.6% of all visits came from the United States
- 118 other countries accounted for more than 100 website visits
- 73.7% of website visits came from a search engine (e.g. Google), an increase of 99% from last year
- 15.6% of website visits came from direct sources (e.g. Bookmarks, going directly to URL)
- 10.7% of website visits came from non-search engine referring sites

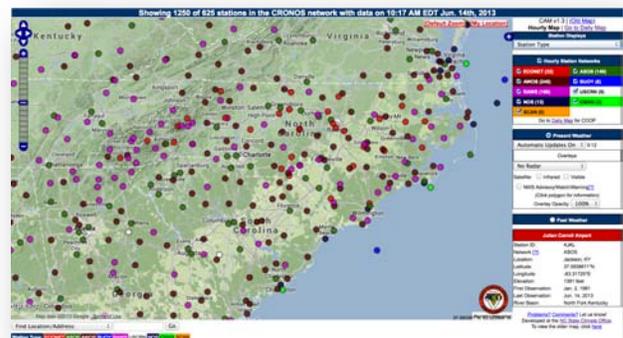
Severe Weather Updates: Last fall, our information pages on thunderstorms and associated severe weather were updated. New graphs and charts were added to help visualize hail, high wind, and tornado numbers, as well as provide raw data.



These new dynamic charts and graphs illustrate the temporal variability of severe weather in our state. There are new options to choose multiple criteria of each type of weather event and dynamically generate customize information on the fly. In addition to providing numbers on reports of events, information about impacts directly associated with these events is also available. Additional features include displaying graphs that contain multiple aspects all on the same image, allowing for direct comparisons of multiple categories (e.g. different F-scales when displaying tornado data). New plots are available on the Thunderstorms section of the website (<http://www.nc-climate.ncsu.edu/thunderstorms/overview>). Team: Colin Loftin, Heather Dinon Aldridge, Adrienne Wootten

Climate Retrieval and Observations Network of the Southeast (CRONOS) CRONOS is the name given to the SCO's climate database, which includes data from surface observational networks, severe weather data, and almost every type of climate data available at the SCO. The CRONOS database serves as the foundation for many SCO products and services.

Usage: Users requested more than 2.3 million data queries through the CRONOS interface – a decrease of 50% as compared to last year. With the development of more sophisticated SCO applications and products, end users now have access to more value-added information and services. In addition, the SCO is now providing terabytes of gridded data to end users. With these new datasets and tools available, there has been a shift away from users requesting raw point data, but an increase in weather and climate information consumption as a whole resulting in a more than doubling of web traffic in the past two years. Network and data support for CRONOS users involve a significant amount of internal data ingest, management, and transfer. The SCO is averaging about 2.3TB of internal climate data transfer each month with about one billion data records selected, updated, or inserted each month.



CRONOS Web Updates: Quality control scores have been added to output of hourly information. This was implemented in order to more accurately show the overall quality score of the data on a unified scale from 0 (good) to 4 (bad).

CRONOS API: An application programming interface (API) allows authorized users to access CRONOS data without going through the web interface. Currently, this tool allows for development of web services that will facilitate internal and external data use, allowing staff, students, and collaborators access to data for research and product development without requiring SQL expertise. In the past year, there were 2.96 million API queries, which represents a decrease of 4.3% over the previous year.

A new API is being developed, which will incorporate many features such as data aggregation, nearest station lookup, and eventually include “best-estimate” data calculated from gridded data. Current work on the API is primarily back-end, linking variables to different data tables, network types, and formula calculation. This will allow the API to generate a best estimate based on other parameters, and in the future, use gridded observation or forecast data in lieu of current or missing observations. Additionally, the API will incorporate variable metadata, such as units, sensor information and first reporting observation of that variable. The API is being written to use a variety of universal output formats, such as JavaScript Object Notation (JSON), and in the future can be called from various programming languages such as Python and Perl. Team: John McGuire, Ashley Hiatt, Aaron Sims, Heather Dinon Aldridge

NC Environment and Climate Observing Network (ECONet)

The ECONet is a network of real-time research-grade monitoring stations that provide observational data on atmospheric and soil conditions. Base funding for the ECONet is provided by NC Agricultural Research Service, which supports the maintenance of sensors at Agriculture Research Stations. Additional support is provided by DENR Air Quality, NC Electric Cooperatives, and individual partners. The ECONet is unique in North Carolina, and provides information that is not collected by any other sensors in the state such as solar radiation and soil conditions.

Station Maintenance: 93 site trips were made over the past year to perform routine or emergency maintenance covering over 14,000 vehicle miles.

- Eight wind monitors were replaced due to damages and upgrades
- Seven integrated wind/temperature/humidity/pressure probes were repaired or replaced
- 44 radiation sensors were recalibrated or replaced for annual maintenance
- Eight soil temperature sensors were replaced due to sensor failures
- 10 soil moisture sensors were replaced due to failure
- One telephone modem was replaced due to damage
- Four enhanced temperature and humidity probes were installed
- The station located at Mt. Mitchell continues to be our most challenging site, with another complete tower collapse on March 30, 2014.
- Leaf wetness sensors were installed at all ECONet stations



Station Enhancements: In late 2013, leaf wetness sensor installation was completed at all stations. Data from these sensors were compared to SCO's operational relative humidity sensor (as well as experimental relative humidity sensors at sites that have them) to better determine when a leaf is wet/dry. Also, this proxy was used to determine the onset/dry-off of dew in the evening/morning during dry summer days. Planned effort with this project will incorporate the new leaf wetness sensors to improve estimates of high humidity environments. SCO plans to extend the use of these sensors in a field campaign this summer with tomato plants at our ECONet site in Fletcher. *Team: Ameenulla Syed, Jim Epps, Sean Heuser, Aaron Sims*

Experimental Station: The SCO continues to operate the experimental station on the roof of Jordan Hall on NC State's main campus. Like all ECONet data, observations from this campus station are also readily available to students and faculty for teaching and research. A prototype weather display with past weather information, current weather conditions, and forecast conditions resides in Jordan Hall on NC State's Main Campus, where most MEAS students gather during the day. Weather data from instruments on the roof provide location specific details on current and past weather, with the goal of enabling viewers to quickly put current conditions in a historical climate context. *Team: John McGuire, Ameenulla Syed, Sean Heuser, Aaron Sims*

New Station Installation: SCO installed a new ECONet tower on August 14, 2013 at the peak of Mount Jefferson State Park. With a station ID of JEFF, this site provides NC DENR Air Quality with updated equipment to

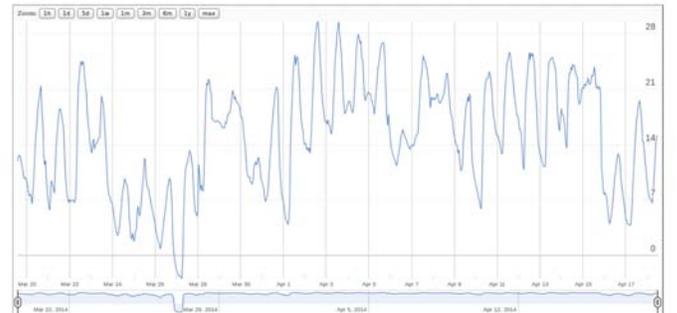


monitor high elevation conditions and communicates the data every 15 minutes. *Team: Ameenulla Syed, Sean Heuser, Jim Epps, Aaron Sims*

Planned Installations: Two new stations are planned for installation during summer 2014. One station is supported through a joint venture with the South Carolina Climatology Office to install a high elevation site along the NC/SC border on Sassafras Mountain. The other site is planned for installation at Isothermal Community College through collaboration with the NOAA/NCSU Cooperative Institute for Climate and Satellites and Facebook. Installation at Isothermal Community College will facilitate collaboration between scientists and local community college students as we embark on an experimental sensor training program. These data will also provide students with real-time weather data for use in the classroom and support climate data needs for the broader industrial, agricultural, and emergency management communities in the area.

Data Quality Control (QC): Data QC took another major leap in 2013 with the implementation of dynamic soil moisture check based on soil properties obtained from Dr. Josh Heitman (Soil Science) as well as the USGS soil survey data. By obtaining soil metadata, such as soil type, field capacity, and wilting point, SCO is now able to use dynamic minimums and maximums for soil moisture values in the QC routines for each station in the ECONet. An improvement to the inter-comparison of precipitation sensors has led to enhanced diagnosis of problems and quicker response times.

Another focus of QC in 2013 was the development of visual charts and graphs to help better examine the data for longer periods. This gives SCO scientists a better understanding of sensor drift and lingering sensor issues that automated QC may not capture. This suite of tools, the ECONet toolbox, contains long-term charts (up to 18 months for hourly data and up to period of record for daily data), percent of available data, as well as sensor metadata and trouble ticket information to inform scientists of possible sensor issues that may not be captured by automated checks.



Using these new tools, several improvements have been made to the QC flags and QC score. In fact, these new checks led to a revamping of our QC score, which is a measure of the accuracy and quality of the data. For the calendar year of 2013, 87.77% of all ECONet data passed with a QC score of 0 (highest quality), while 3.66% of all ECONet data scored a QC 3 (failure to pass any level of quality control).

Research has begun to create an inter-sensor comparison between air temperature and soil temperature using linear regression. While still in the early phases, a seasonal time frame has proven successful in creating a regression formula for predicting soil temperature using air temperature. The final goal is to QC soil temperature data, and provide a proxy for missing/faulty data.

Undergraduate students have been helping out with QC thanks to the new QC interface that was released in summer of 2013. This page helps better flag suspicious data and alert technicians of possible sensor malfunctions. These students are exposed to real-time challenges associated with running a research grade mesonet. They are learning to analyze data trends and explore new QC methods. Their help has made the process of manual QC more efficient.

Team: Sean Heuser, Aaron Sims, John McGuire, Heather Dinon Aldridge

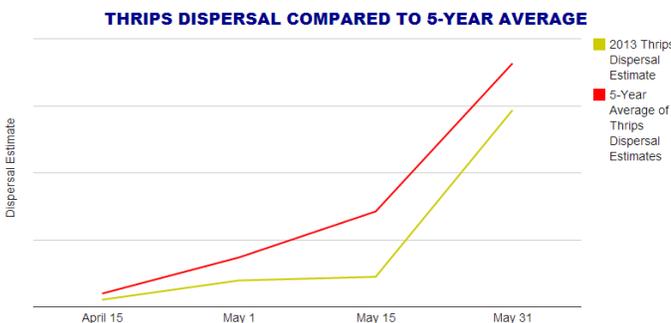
Enhancing Observations through Metadata: Metadata continues to be recorded for the National MesoNet project. The SCO continues to provide routine ECONet observation files to the NOAA Meteorological Assimilation Data Ingest System (MADIS) gateway for national dissemination to research groups. The SCO is also continuing development on an in-the-field management system that will enable technicians to update all station metadata, including taking photos and logging station visit activities using a mobile device. Currently, these metadata are available through the ECONet toolbox. As part of our collaboration with Coastal Carolina University, SCO added three pier-based stations and one sodar station to the MADIS feed.

Team: Sean Heuser, Jim Epps, John McGuire, Aaron Sims, Ameenulla Syed

Climate Support for Agriculture

Peanut Disease Advisories: 2013 brought the 10th year of our ongoing partnership with Dr. Barbara Shew in NCSU Plant Pathology to provide routine advisories for two peanut foliar diseases: peanut leaf spot and peanut sclerotinia. *Team: Aaron Sims, Ashley Hiatt, Ryan Boyles*

Climate Information for Thrips Risk Assessment: In collaboration with Drs. George Kennedy, Hannah Burrack, and Thomas Chappell (NCSU Entomology), the SCO has developed a web-based advisory system to evaluate the risk of thrips in tobacco. Tobacco thrips are vectors of Tomato Spotted Wilt Virus (TSWV), which causes heavy tobacco crop losses in NC. The website uses a combination of past weather data, climate data, and forecasted temperatures and

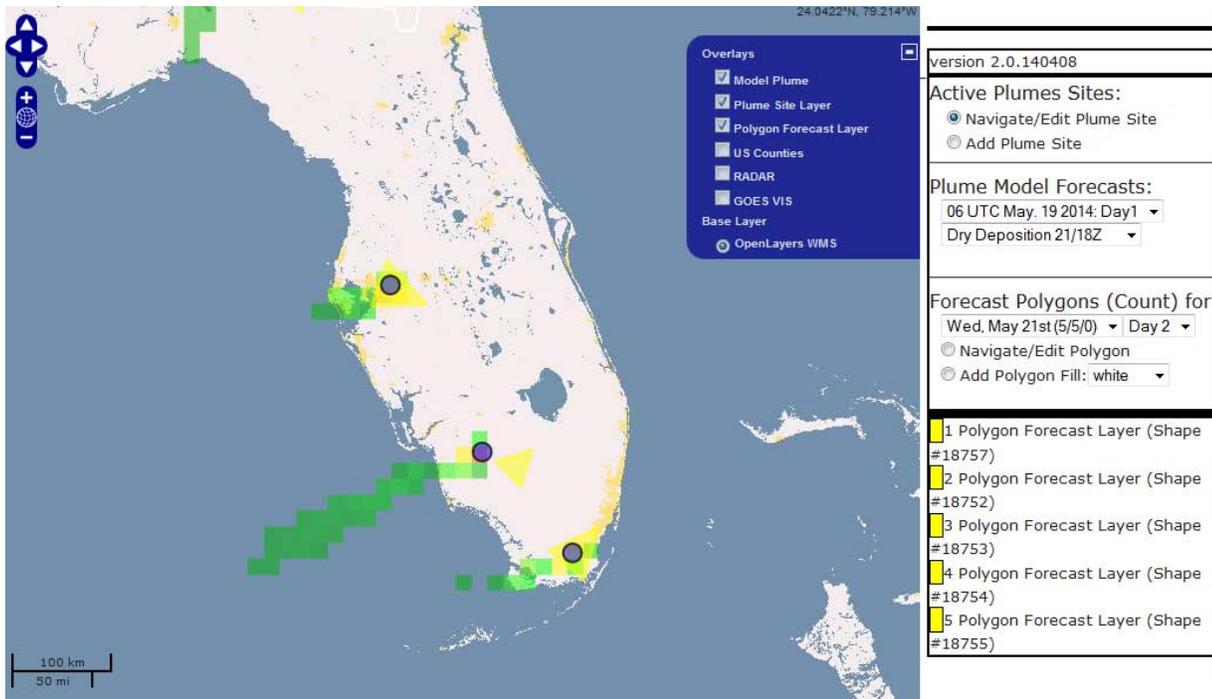


precipitation to predict thrips flight dates and relative numbers of dispersing thrips for a user's location. In 2013-2014, a personalized risk estimate was included to help users to prepare for the upcoming growing season. This risk estimate, combined with the predicted thrips flight dates, is presented in dynamic visualizations to help better communicate seasonal TSWV incidence risk. Extension agents tested these enhancements during the 2014 tobacco planting season. (<http://www.nc-climate.ncsu.edu/thrips/>) *Team: Geneva Ely, Rebecca Cumbie*

Late Blight for Potatoes and Tomatoes: In collaboration with Dr. Jean Ristaino (NCSU Plant Pathology), NCSU joined a team of plant pathologists in 2010 to successfully propose development of an international monitoring and alert tool for Late Blight that affects tomatoes and potatoes. The SCO provides technology support and website administration. This year, new backend improvements include enhancements to security and login functions. During the past year, there were 261 confirmed late blight cases across the United States and Canada. As part of the monitoring effort, there were 326 alert sites setup by 303 active users. (<http://usablight.org/>)

Team: John McGuire, Sean Heuser, Madeline Pope, Ryan Boyles

Cucurbit Downy Mildew Forecasts: SCO continues ongoing collaboration with Dr. Peter Ojiambo, Mr. Thomas Keever, and Ms. Wendy Britton (NCSU Plant Pathology) to provide national operational integrated pest management (IPM) forecasts for Downy Mildew that affects cucurbits (cucumbers, melons, squash). As part of this project (known as ipmPIPE), SCO provides weather information, technology support, and dispersion forecast guidance. While the formal USDA project has ended, SCO continues to work with partners in NCSU Plant Pathology to maintain the website (<http://cdm.ipmpipe.org>) and forecasting tools. Over the past year, this included developing a new forecasting interface (image below) and website that will allow for easier modifications to content by Plant Pathology staff.



During the 2013 growing season (April – October), the website averaged 500-1,500 unique visitors each month, with the 2013 session total of 8,125, representing an increase of 18.2% over the 2012 growing season (6,876). There were 290 confirmed reports of cucurbit downy mildew during that period.

Team: John McGuire, Aaron Sims, Ryan Boyles

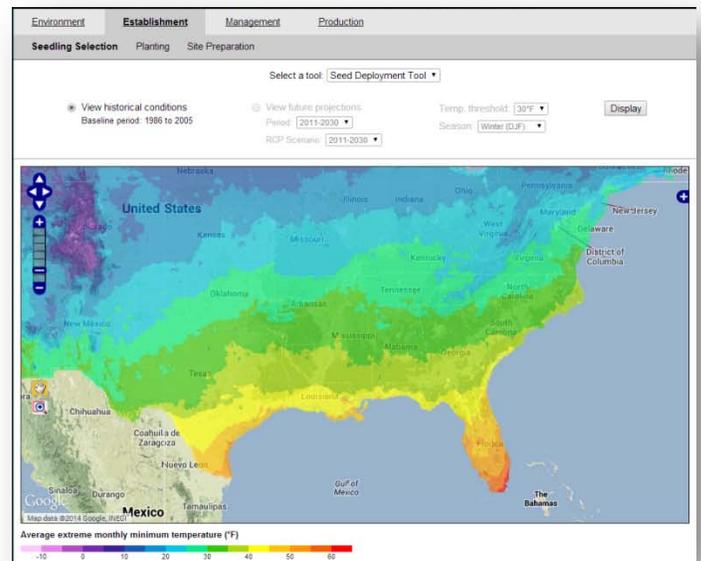
Climate Support for Forest and Natural Resource Management

PINEMAP: Climate Support for Southern Conifer Management: In collaboration with 42 other investigators from across NC State University and the southern US, the SCO successfully proposed a 5-year project to USDA in 2010 for research, extension, and educational activities to improve the management of pine trees in the southern US. The SCO will specifically serve as the conduit to the other State Climatologists, developers of a decision support system based on AgroClimate.org, and the climate extension resource for all partners. Effort in the past year includes:

- Connecting forestry extension partners with southern State Climatologists who have served as presenters at regional workshops for natural resource professionals
- Developing a peer-reviewed fact sheet on *Drought and Southern Forests* that translates PINEMAP research topics to landowners (http://www.pinemap.org/publications/fact-sheets/Drought_Southern_Forests.pdf)
- Extending climate expertise as part of the PINEMAP outreach including:
 - Assistance with several PINEMAP webinars (for internal and external users) to promote understanding of climate science and collaboration and knowledge sharing among the interdisciplinary PINEMAP team.



- Reviewed materials (factsheets, PPTs, websites, etc.) for PINEMAP audiences including private landowners, limited resource landowners, industrial/corporate landowners, and state forest agencies
- Provide guidance to the research sub-groups as to which climate datasets (historical data and future projections) are the most useful for PINEMAP
- Providing 17 invited presentations about climate and climate change related to forestry
- Continuing to develop new partnerships with US Forest Service Southern Research Station and the Association of Natural Resources Extension Professionals (ANREP) Climate Science Initiative (CSI), with Heather serving on the planning committee for ANREP CSI in-service training in Minnesota during October 2013
- Hosting the PINEMAP gridded datasets (~6 Terabytes) on THREDDS data server, which allows for automated requests and machine-to-machine data manipulation
 - PINEMAP gridded datasets:
 - Historical gridded surface meteorological dataset (U. of Idaho): <http://metdata.northwestknowledge.net/>
 - Dynamically downscaled climate projections from North American Regional Climate Change Assessment Program (NARCCAP): <http://www.narccap.ucar.edu/>
 - Statistically downscaled climate projections using Multivariate Adaptive Constructed Analogs (MACA) method (U. of Idaho): <http://maca.northwestknowledge.net/>
 - THREDDS PINEMAP catalog: <http://convection.meas.ncsu.edu:8080/thredds/catalog/pinemap/catalog.html>
 - THREDDS PINEMAP data documentation: <https://sites.google.com/a/ncsu.edu/thredds-data-server-frequently-asked-questions/>
- Completing over 10 PINEMAP data requests for point or gridded datasets aggregated spatially and/or temporally to meet the needs of PINEMAP researchers
- Working with partners in the multi-state Southeast Climate Consortium and other PINEMAP colleagues to plan the Decision Support System (DSS). A prototype DSS website has been developed and is available at http://nc-climate.ncsu.edu/pinemap_dss/. Tools that have been developed initially include:
 - Seed Deployment Tool based on historical average extreme monthly minimum temperatures
 - Carbon Hotspot Tool to indicate regions with large pools of carbon (hotspots)
 - Stand-level thinning decision support tool that recommends biologically optimum thinning schedules
 - Green Weight Map Output from the Growth and Yield model which projects future Loblolly pine production based on different emission and management scenarios

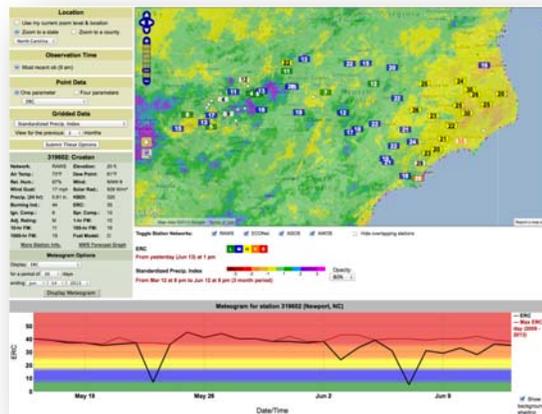


Team: Heather Dinon Aldridge, Ryan Boyles, Corey Davis, Andrew Martin

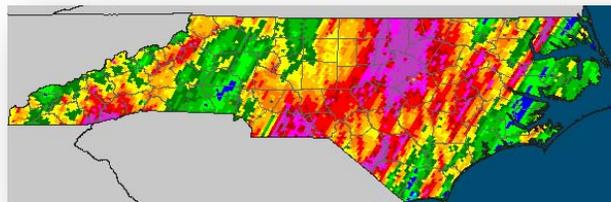
Climate Tools for Pine Tree Growers: As part of the State Climate Office’s continued extension work with the forestry sector, several tools have been developed to quantify some of the known climate-based risks for

growing pine trees. Extreme cold temperatures and infrequent precipitation can hinder tree growth, especially in the first few years of establishing a stand. The occurrence of these events can be viewed in graphs based on historical climate data from a user-selected location. Recent drought conditions can also be displayed using the U.S. Drought Monitor's assessments for the user's county of interest. (http://www.nc-climate.ncsu.edu/forestry_tools.php) Team: Corey Davis, Heather Dinon Aldridge, Ryan Boyles

Fire Weather and Smoke Guidance: The Fire Weather Intelligence Portal, a tool for monitoring past, current, and forecasted weather and fire risk conditions in North Carolina, was officially released to NC Forest Service users last June. Since then, several new datasets have been added to the Portal, including gridded fire weather forecasts from the Southern High Resolution Modeling Consortium (SHRMC) and the National Weather Service office in Greer, SC. In the year since its release, the Portal has received more than 25,000 views from more than 3,000 unique visitors. In addition to users at the NC Forest Service, the Portal has been routinely used by National Weather Service forecast offices in North Carolina, South Carolina, and Virginia; private and professional foresters; and other groups interested in monitoring local conditions. (<http://nc-climate.ncsu.edu/fwip/>) Team: Corey Davis, Ryan Boyles



Precipitation Monitoring and Alerts for DOT Stormwater Management: NC DOT continues to support the SCO to provide radar-based precipitation alerts and monitoring tools. There are currently 1,072 active user accounts for this product with 1,540 active sites monitored. This partnership with NC DOT has received three state and national awards. Team: John McGuire, Aaron Sims, Ashley Hiatt



NOAA Southeast Regional Climate Center

UNC-Chapel Hill and NCSU were awarded the NOAA Southeast Regional Climate Center (SERCC) in 2007. As part of that award, the SCO supports and maintains the Applied Climate Information System (ACIS), which serves as the climate database for all six NOAA Regional Climate Centers. Additionally, the SCO is responsible for developing and maintaining the SERCC web services and online climate tools (<http://www.sercc.com/>). Partners at UNC-CH include Chip Konrad, Chris Fuhrmann, William Schmitz, and Maggie Kovach.

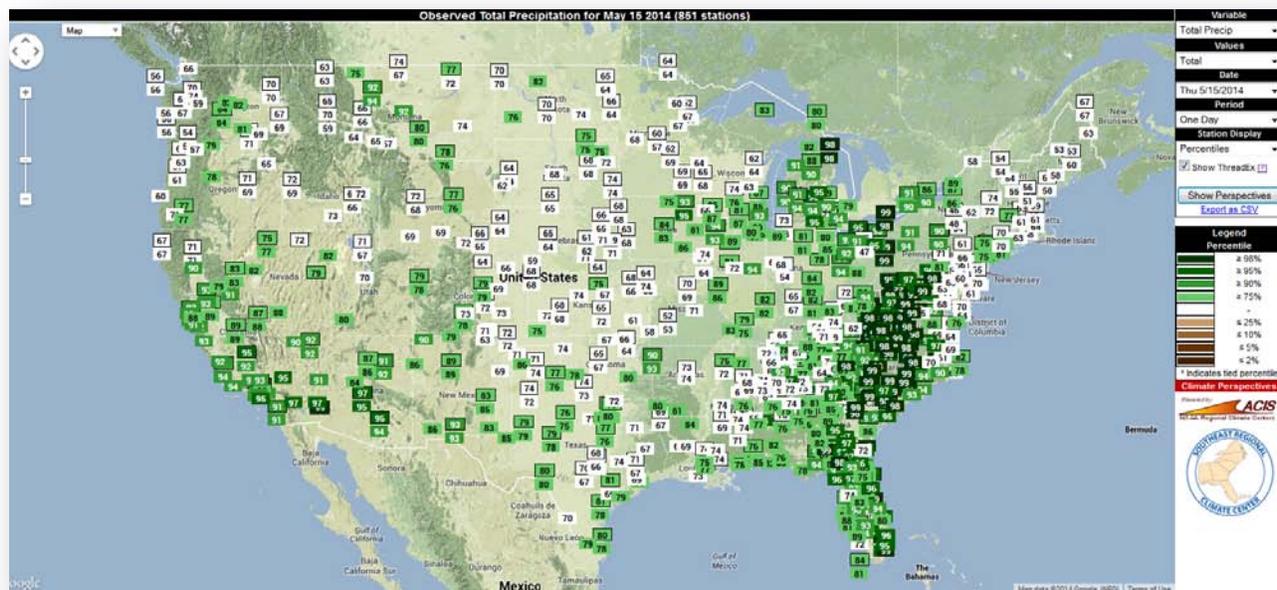
SERCC Web Traffic

Usage: The number of website visits (sessions) was 188,739, an increase of 14.9% over the previous year (164,254). Note that data is not available for February 2014, but the period is included.

- The largest number of visits on a single day was 5,539 visits on January 6th, 2014
- 92.8% of all visits came from the United States
- Among US States, the most visits came from NC (14%), FL (13.4%), GA (11%), VA (6.5%), CA (4.6%), SC (4.2%), TX (3.8%), and AL (3.5%)
- 70.5% of website visits came from search engines (e.g. Google), an increase of 28.8% over last year
- 18.33% of website visits came from direct sources (e.g. Bookmarks, typing in address into URL), an increase of 6.2% over last year

- 11.2% of website visits came from non-search engine referral sites, a decrease of 25.8% over the previous year

Climate Perspective Updates: Updates and enhancements were made to the regional climate information tool known as Climate Perspectives. A new “most similar city” algorithm was developed that takes into account both high and low average temperatures for a series of locations across the entire United States. These values are generated across the entire country for NWS primary forecast points and across many daily observation stations in the Southeastern United States (image below). *Team: John McGuire*



Climate and Public Health: In 2013, the SCO continued to focus effort on the development of a prototype tool to combine climate data with hospital emergency department admissions. This tool allows researchers to explore the relationships between emergency department admissions data and local climate conditions. These relationships, if robust, will enable early warning for public health officials.

The prototype tool has been presented several times to the NC Climate and Health working group since its initial development, and early research results obtained from the tool were recently shown at the Carolinas Climate Resilience Conference in April. Currently, this tool allows users to search for emergency department records based on these user inputs: primary and secondary diagnostics codes, dates and years of interest, and locations. Users can also pull corresponding weather records, and generate “reference periods” for emergency department admissions to help determine when excess morbidity rates occur. After initial data retrieval, the results can be aggregated over different temporal and spatial scales, and narrowed down by demographics, from which summary tables with basic counts and per capita rates can be generated.

Initially, this prototype tool referenced stations in the National Weather Service’s (NWS) Cooperative Network for gathering corresponding weather data. In order to expand the types of weather parameters available – namely heat index and wind chill – the tool was modified to retrieve data from hourly stations in the ASOS, AWOS, ECONet and RAWs networks. A separate tool was also developed in conjunction with this climate-health research tool to provide users with a frequency distribution of temperature for select time frames and locations across the state. Preliminary research results from both tools will be used in the upcoming year to develop a Heat-Health Vulnerability Tool geared toward public health officials, NWS personnel, the state emergency response team, and others who could potentially target messaging of heat warnings to particular groups or areas. *Team: Ashley Hiatt, John McGuire, Aaron Sims, Ryan Boyles*

APPLIED RESEARCH

Research efforts in the SCO are connected to our unique data resources and established relationships with other disciplinary scientists. In the past year, we continued work to improve our ability to model and estimate climate conditions for times and locations where observations are not available, including a new emphasis on humidity and leaf wetness to support agricultural pest management. We also continue to develop methods for improved drought monitoring, precipitation monitoring, and climate forecasting both with partners at NCSU and with research collaborators across the nation. In 2013-14, we enhanced our research collaborations with ecosystem and biological scientists through workshops, climate modeling, and research publications focused on climate impacts to natural and managed landscapes.

Presentations and Publications

- 4 manuscripts were successfully published in peer-reviewed journals
- 4 manuscripts are in development or currently in submission
- 9 presentations were given at 4 scientific conferences
- 6 staff and students attended 4 scientific meetings and conferences

Model Reanalysis Case Study: To improve the integration of climate observation networks with atmospheric models, several different data assimilation methods and model configurations were tested in a case of cold-air drainage in the Yadkin Valley of North Carolina. Cold-air drainage occurs when calm, cold nights allow for cold air to flow down terrain, pooling in valleys and low-lying areas. Cold-air drainage, especially in the early spring, can be damaging to crops if temperatures fall below freezing. Knowing these risks can help growers prepare for cold events, such as purchasing row coverings or using irrigation to help insulate the crops. By using weather models to compare against observations, a climatology can be created showing areas at highest risk for these events. Additionally, using a model can help improve spatial coverage, especially in areas of complex geography. In an evaluation case study in the Yadkin Valley of North Carolina, observations matched most closely with model data provided by the National Weather Service's (NWS) Real-Time Mesoscale Analysis (RTMA), which can be used as a near-time estimate of current conditions. Due to the limited history of number of years where RTMA is available, the best prospects for developing a long-term climate reanalysis were found by using a weather model (WRF) that uses data assimilation over multiple time-windows of both observations and the "adjusted" model forecast that best matches these observations. *Team: John McGuire, Aaron Sims, Ryan Boyles*

Leaf Wetness: As part of the Late Blight project, leaf wetness sensors were installed across North Carolina to monitor when a leaf was considered "wet" and compare it to co-located relative humidity readings. The project has two major goals:

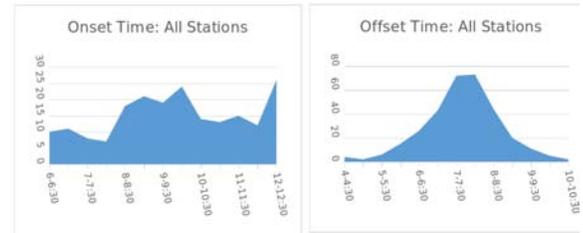
1. To determine a relationship between relative humidity and leaf wetness so relative humidity can be used as a proxy since leaf wetness is not routinely measured at weather stations in NC yet is vital for disease reproduction in tomatoes and potatoes, and
2. To give an estimate of dew onset and dry-off during summer months to better alert growers of the risk of disease emergence. Between May and November of 2013, experimental leaf wetness sensors were



deployed across all ECONet stations in North Carolina. Using laboratory tests and background research, SCO considered thresholds of leaf wetness at 300 mV and relative humidity of 90% for a wet leaf. Data from all ECONet stations were analyzed from June 2013-April 2014. A “correct success” was determined by humidity values $\geq 90\%$ and leaf wetness values ≥ 300 mV or if $RH < 90\%$ and $LW < 300$ mV. The correct success rate for all stations during our study period was 85.3%. For the second goal, SCO considered dry days in July to capture dew onset and dry-off. Onset of dew was defined as a positive change in leaf wetness by more than two units over a 30-minute period. A negative change in leaf wetness of less than two over a 30-minute period is the definition of dew dry-off was defined as The onset of dew occurred most frequently between 8-9pm with dew dry-off occurring most frequently between 6:30-7:30am. Future work currently involves getting an annual average of dew onset/dry-off as well as validating the sensor with human observations of dew onset and dry-off on tomato plants in the field.

Collaborators: Dr. Jean Ristaino (NCSU Plant Pathology).

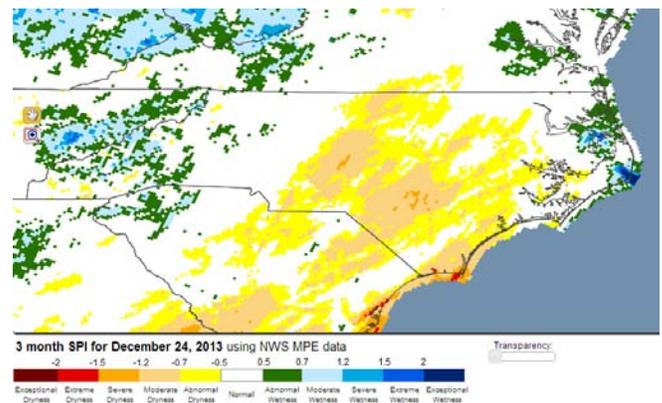
Team: Sean Heuser, Madeline Pope



Relative Humidity Intersensor Comparison: Peanut disease modeling is critical to peanut farmers across our state. Our partner in NCSU plant pathology, Dr. Barbara Shew, informed us that her disease model was not issuing any alerts because of possible issues with humidity sensor accuracy. As part of this research, 10 relative humidity sensors considered to be more advanced (and more expensive) were installed to be co-located with our current relative humidity instruments. Relative humidity values were compared between the two sensors during June 2013 through January 2014. Results show that the advanced experimental sensors reported almost 7% higher than our standard humidity probes during precipitation events. Based on this, SCO is deploying an additional 10 advanced sensors in 2014 with plans to fully deploy new sensors across the ECONet by 2015.

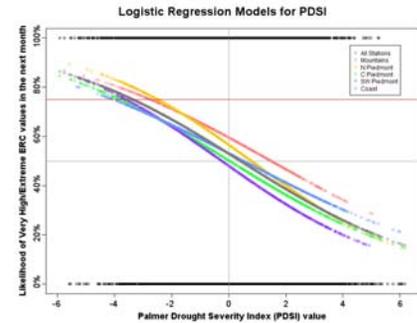
Team: Sean Heuser, Madeline Pope, Jim Epps, Ameenulla Syed

Radar-based Drought Indices: Most drought products that exist today are county-level at their finest resolution or are based on interpolated rain gauge data. A Standardized Precipitation Index (SPI) algorithm that uses Multi-sensor Precipitation Estimates (MPE) in its calculation was developed by Texas A&M University (TAMU). The resolution of MPE and the resulting SPI is approximately 5km, and has the ability to capture high spatial variation in drought severity. SCO was awarded a project with partners at TAMU and Purdue University to produce a routine SPI product based on MPE. Since MPE has a short period of record, maps are generated using statistics for stations that were grouped into regions using cluster analysis based on two separate normals periods: 1971-2000 and 1981-2010. This product was presented at the American Association of State Climatologists Annual Meeting in July 2013 as well as shared with the US Drought Monitor listserv, and through a blog post by the SCO. Currently, it is being widely used and evaluated by experts across the nation as supplemental guidance for creating the weekly US Drought Monitor. Research will be forthcoming in summer 2014 on how well the MPE-based SPI compares to analogous SPIs calculated independently using different datasets and statistical methods. Two additional drought indices, the Palmer Drought Indices (PDI) and the Standardized Precipitation Evapotranspiration Index (SPEI) are planned for addition to the website in 2014. The PDI are based on a simple climate balance and are commonly used in drought monitoring. Calculations for these indices are nearly mature and maps are expected to be added to the website in early summer 2014. The SPEI has an algorithm that is computationally similar to SPI, but is based on the balance between precipitation and potential



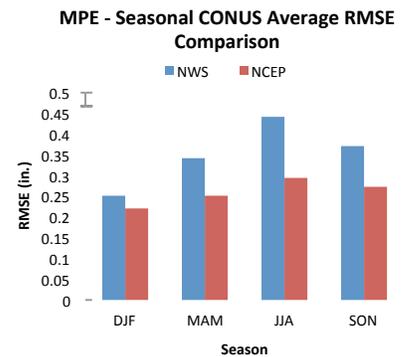
evapotranspiration rather than only precipitation. Work on calculating the SPEI began in early 2014 and is expected to be largely completed in late 2014. *Collaborators: John Nielsen-Gammon (TAMU) and Dev Niyogi (Purdue). Team: Rebecca Cumbie, Melissa Mainhart, Jessica Miller, John McGuire, Aaron Sims, Corey Davis, Ryan Boyles*

Fire Risk Predictability: As a supplement to the fire risk information provided in the Fire Weather Intelligence Portal, research conducted at the SCO examined the climatology and predictability of these fire risk parameters. Two of the most commonly used parameters are the Keetch-Byram Drought Index (KBDI), which is related to dryness in the soil, and the Energy Release Component (ERC), which is related to dryness in fuels such as logs, sticks, and duff. To make interpretation and comparison of these parameters easier, a methodology was outlined for calculating a KBDI departure from normal and fire risk rating classes based on ERC values. A study of fire risk predictability compared these parameters with several large-scale climate forcings. The greatest correlations with the fire risk parameters were found with short-term drought indices such as the Palmer Z-Index, the one- and two-month Standardized Precipitation Index, and one longer-term drought index: the Palmer Drought Severity Index. Predictive models were established comparing the previous month's drought indices to the next month's fire risk, but most models provided little to no improvement over the persistence, or previous month's, fire risk values. A set of logistic regression models examined the historical likelihood of having Very High or Extreme-rated ERC values – which have been found to be associated with observed fire activity at least 80% of the time – based on the previous month's PDSI, Z-Index, and short-duration SPI values. These results could be used to identify the thresholds at which these indices are associated with, for instance, a 75% likelihood of having elevated ERC values in the following month. This could be useful information for groups, such as the North Carolina Forest Service, that regularly respond to wildfires across the state. *Team: Corey Davis, Ryan Boyles*



Evaluation of Multi-Sensor Precipitation Estimates (MPE):

The SCO uses MPE products provided by NWS River Forecast Centers and the National Center for Environmental Prediction (NCEP) in several products and tools used by DOT, DWR, TVA, and others. As part of the ongoing use of the data, SCO has completed an evaluation of the NCEP Mosaic of MPE across the eastern United States (2002-2012). This evaluation has been accepted for publication, and two additional manuscripts are in preparation. The first additional manuscript evaluates MPE related to coastal vs. inland precipitation. The second additional manuscript compares the NCEP and NWS Mosaics of MPE across the continental United States. *Team: Adrienne Wootten, Ryan Boyles*



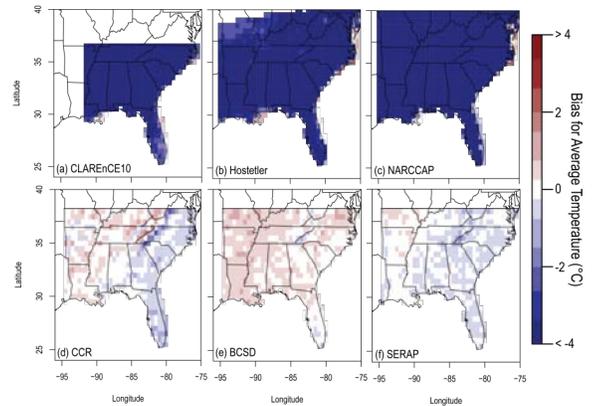
Bias Correction of Multi-Sensor Precipitation Estimates: Previous research conducted at the SCO shows that MPE have a significant bias when compared to an independent station network. Based on these findings, SCO has been attempting to correct these biases through several statistical techniques. One bias correction method uses precipitation observations from an independent daily station network. This involves modeling the relationship between gridded data and point observational data. Analysis from these results will then be used in a Bayesian Spatial Quantile Regression developed by Dr. Brian Reich (Department of Statistics). Preliminary results from this analysis were presented at the American Meteorological Society's 28th Conference on Hydrology. *Team: Geneva Ely, Adrienne Wootten*

Evaluation of Downscaled Climate Projections

Local level projections (or downscaled climate projections) of climate change are being used more commonly in ecosystem modeling and conservation planning related to climate change. The proliferation of downscaled climate projections often leaves users questioning which dataset is appropriate for their application. The goal of this project was to synthesize the information available from these local level projections, evaluate several sets of projections with regards to ecological modeling in the Southeast U.S., and provide guidance for the ecological modeling community on how to choose a downscaled climate projection for their application. Overall, the report, which has

been accepted for publication as a USGS Technical report, highlights the challenges of modeling climate in the complex topography of the Southern Appalachians and under the influence of hurricanes. In addition, the report emphasizes the need for further engagement between climate modelers and the ecological community. In addition to the report, a manuscript highlighting the key conclusions of the report is in preparation.

Collaborators: Adam Terando (Southeast Climate Science Center), Kara Smith and Frederick Semazzi (NCSU), Lydia Stefanova and Vasu Misra (Florida State University), Tom Smith (USGS Southeast Ecological Science Center), and David Blodgett (USGS Center for Integrated Data Analytics). Team: Adrienne Wootten, Ryan Boyles



Assessing Climate Guidance Needs of Ecosystem Scientists: Over the past year, the SCO has undertaken multiple efforts to assess the needs of ecosystem scientists in the Southeast United States with regards to climate information. As ecosystem scientists work to understand the affect that climate has on species and ecosystems, there is an increasing need from this group to understand how climate model data are created and how they can be appropriately used. In addition, as ecosystem scientists are working to ascertain the impacts of climate, the SCO is working with them to document critical climate variables for species and ecosystems in North Carolina and in the Southeast. As part of our involvement with the US Department of Interior’s SE Climate Science Center (based at NCSU), the SCO has helped organize two workshops to assess the needs of ecologists in the Southeast U.S. and Puerto Rico. The first, held in Raleigh during May 2013, provided guidance for an evaluation of downscaled climate projections specific to the needs of the Southeast ecological community. The second, held during November 2013 in San Juan, PR, worked to assess the needs of ecologists specific to Puerto Rico and is being used to drive the creation of downscaled climate projections for Puerto Rico that answer the needs of this community. *Collaborators: Adam Terando (SECSC), Jared Bowden (UNC Institute for the Environment), Kara Smith and Frederick Semazzi (NCSU), Lydia Stefanova and Vasu Misra (Florida State University), Tom Smith (USGS Southeast Ecological Science Center), and David Blodgett (USGS Center for Integrated Data Analytics). Team: Adrienne Wootten, Ryan Boyles*

Defense Coastal / Estuarine Research Program (DCERP): In summer 2012, the SCO joined a team of scientists headed by RTI International in the second phase of the Defense Coastal / Estuarine Research Program. As part of DCERP, four module groups are working to assess the impact that climate change will have on ecosystems using Marine Corp Base Camp Lejeune in NC as the study domain. These are the aquatic / estuarine, terrestrial, coastal wetlands, and coastal barriers. Given the different modeling efforts in each ecosystem module, the goal of the SCO is to ascertain the climate sensitivities of each module and produce fine-resolution climate change projections and historical climate conditions over the base for these modeling efforts. SCO will use the guidance from its ecosystem workshops and discussions with DCERP team to prepare its science plan for climate projection modeling beginning in late 2014. More information is available at <http://dcerp.rti.org>. *Team: Adrienne Wootten, Ryan Boyles*



Educational Outreach

As North Carolina's primary statewide resource for informal climate education, outreach programming is a substantial focus for SCO staff and students with more than 40,000 direct educational outreach contact hours. We provide direct outreach for dozens of school and community groups, participate in large science education events such as StormFest and NC Science Festival, and push a range climate news and information to the public via our blog and social media. We also hosted our 11th year with student interns from Centennial Campus Magnet Middle School and engaged NC teachers through the CoCoRaHS grassroots rainfall network.



Undergraduate & Graduate Student Training

- SCO supported 10 undergraduate and 2 graduate students over the past year
- Mr. Corey Davis and Mr. John McGuire received their Master of Science degrees from the Department of Marine, Earth, and Atmospheric Sciences

Invited Presentations and Visitor Programs

- Total Direct Educational Outreach Contact Hours: 44,702
- SCO staff provided 35 presentations by invitation
- SCO provided tours and programs for 22 visitor groups
- SCO participated in several large group events, including StormFest, NC Science Festival, and Chowan Edenton Environmental Group Green Fair

Over the past few years, SCO scientists worked with one of our graduate students, who was completing a Master of Arts in Teaching, to renovate our outreach tour experience for K-12 visitor groups. Overall, SCO tours now include more hands-on activities. Training was provided to SCO scientists on how to communicate best with different age groups and on which science experiments were suitable for different age groups. In addition, a website was created with detailed information about our educational tours for interested student groups (http://nc-climate.ncsu.edu/education/tour_overview).

During May 2013 through April 2014, SCO scientists engaged with several different sectors by co-hosting and/or presenting at various workshops, conferences, meetings, and symposium, including:

- Co-organized and presented at two PINEMAP workshops on climate and climate change for natural resource extension professionals
- Hosted and presented at Regional Climate Variations and Change for Terrestrial Ecosystems Workshop (<http://www.esajournals.org/doi/abs/10.1890/0012-9623-95.1.96>)
- Led S-290 training on basic weather processes for NC Forest Service

- Co-organized and presented at Association of Natural Resource Extension Professionals (ANREP) National Extension Climate Science Initiative Conference (<http://sfec.cfans.umn.edu/Conference/index.htm>)
- Presented three posters at the College of Science Access Day

Centennial Campus Magnet Middle School Internship: The SCO hosted 8th grade students from Centennial Campus Magnet Middle School (CCMMS) for an internship on weather and climate. This is the 11th consecutive year of the internship, which is the longest running internship between CCMMS and any one organization. This year, the SCO changed the format of the CCMMS internship by shortening the program into an 8-week program and offering it twice – once during Fall 2013 and a second time during Spring 2014 – which allowed for us to engage with four students instead of two. Each week of the internship



consisted of two parts: 1) a one-hour lab where students learned about weather principles, and 2) a dedicated hour to focus on their project that applied those weather concepts. SCO hosted students for the fall semester from late September until mid-December. These two students' project focused on the probability of a late season freeze to Fraser Fir trees in the mountains of North Carolina. During the spring semester, which ran from late January until early March, two new students studied chill hours and the likelihood of soft scald disease for apples grown in North Carolina as well as the types of apples that could grow in non-apple producing regions of North Carolina. *Team: Sean Heuser, Rebecca Cumbie, John McGuire, Heather Dinon Aldridge, with help from all staff members.*



StormFest: StormFest is an annual event held at the Museum of Natural Sciences in downtown Raleigh, in which attendees learn about North Carolina's weather and climate through panel discussions with broadcast meteorologists, weather spotter training, and visits to booths hosted by various weather organizations, including the National Weather Service and the SCO. The 2013 event was held on Saturday, May 4th from 9am to 5pm and attracted over 3,500 visitors of all ages. In 2014, the event convened on Thursday, March 6th from 5pm to 9pm in the Nature Research Center as part of Severe Weather Awareness Week. During both years, our SCO booth featured:



- mini weather station with a live data feed,
- tornado machine built by one of our own SCO scientists, John McGuire,
- hands-on demonstration called the can crushing experiment,
- mini weather wall highlighting some of our products and services such as CRONOS map,
- several posters and brochures on weather and climate-related topics,

- sign-up sheets for our Climate Blog and for a citizen science project called CoCoRaHS, and
- contest to guess the number of M&M's (2013) or marshmallows (2014) in our CoCoRaHS rain gauge.

The 2013 CoCoRaHS contest winner was Zavier from Rolesville, with a guess of 1,570 M&M's, which was within 3 M&M's of the correct number (1,573) – pretty impressive for a 5th grader! In 2014, the CoCoRaHS contest winner, Steve from Knightdale, guessed 580 marshmallows – only 16 off from the correct number (564). Both winners received an official CoCoRaHS rain gauge as their prize.

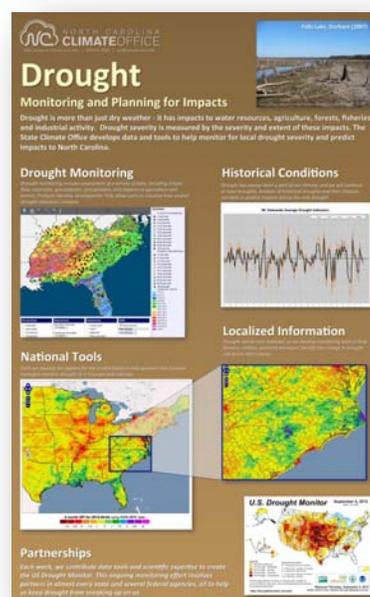
Team: Heather Dinon Aldridge, Sean Heuser, Greg Deleruyelle, Adrienne Wootten, Ashley Hiatt, Melissa Mainhart, Jim Epps, Corey Davis, Rebecca Cumbie, John McGuire, Geneva Ely



Outreach Posters for Key Target Areas and Themes: Over the past year, SCO scientists have developed several posters that highlight climate services for key target areas and/or themes of our office. These posters are mounted on our display boards to capture the attention of SCO visitor groups and are used for outreach programs. *Team: Adrienne Wootten, Ryan Boyles, Heather Dinon Aldridge, John McGuire, Sean Heuser, Ashley Hiatt*

Topics include:

- Overview of Climate Services
- Agricultural Products
- Current SCO Datasets
- Overview of NC ECONet
- NC ECONet Tower and Sensors
- Drought Monitoring and Planning for Impacts
- Precipitation Monitoring and Decision Support



Community Collaborative Rain, Hail & Snow Network (CoCoRaHS): Through CoCoRaHS, thousands of volunteers, young and old, document the size, intensity, duration and patterns of rain, hail and snow by taking simple measurements in their own backyards. These reports help supplement existing observations from local weather stations and fill in gaps where there are no nearby stations. We led the establishment of CoCoRaHS in North Carolina in 2007 and in 2014 we have worked to recruit new volunteers for the program, especially encouraging participation from local schools and areas with data gaps. Our recruiting efforts include:

- the CoCoRaHS contest at the 2013 and 2014 StormFest event,
- a WRAL news story during 2013 CoCoRaHS March Madness (added 60 new volunteers),
- an introduction to CoCoRaHS during our invited presentations and visitor programs, and
- an engagement with Burlington teachers, which led to 19 new gauges being donated to them by LabCorp.

Every year, a friendly recruiting contest called CoCoRaHS March Madness takes place between all 50 states to see who can recruit the most new volunteers during the days of March. North Carolina won the contest in 2011 and 2012, taking home the CoCoRaHS Cup! During this past year, North Carolina was once again the “Traditional Count” winner of the contest, recruiting an impressive 155 new volunteers during the month of March! Over 1,000 new observers signed up across the nation during this event.



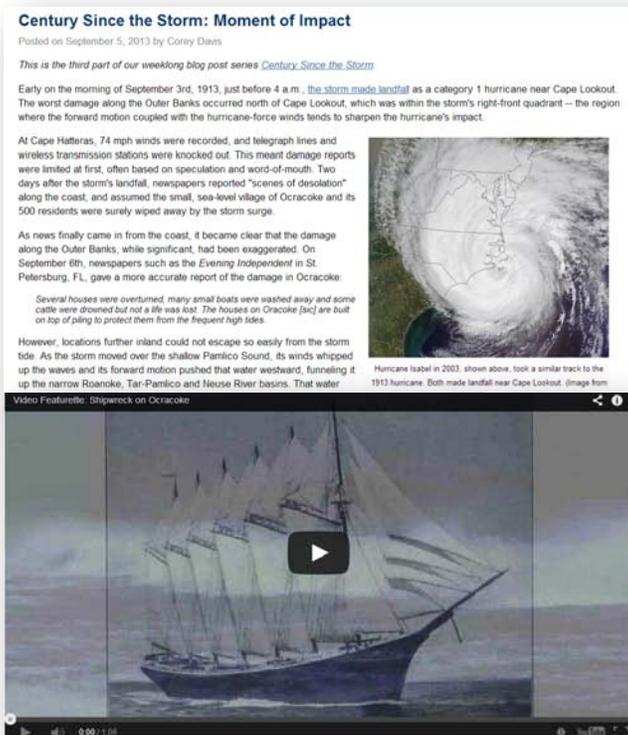
Thanks in part to our SCO recruiting efforts and the efforts of many others across the state, North Carolina has the second highest number of schools signed up as CoCoRaHS observers – the highest number is Colorado, the birthplace of the CoCoRaHS program. *Team: Heather Dinon Aldridge with contributions from all SCO staff*

Climate Science Communication

SCO Climate Blog: The State Climate Office has continued to routinely communicate news and scientific information via its Climate Blog (<http://nc-climate.ncsu.edu/blog>). Currently, 538 individuals and group listservs are receiving notifications of new blog entries, which is an increase from a total of 525 at this time last year, with hundreds more reached via science teacher and Cooperative extension email lists. In the past 12 months, 51 separate blog posts have received more than 16,000 combined views. These posts have covered a wide range of topics, including:

- monthly and seasonal climate recaps and outlooks,
- summaries and climate perspectives about recent weather events,
- weather and climate basics, and
- student projects and research.

These blog posts have used multimedia such as interactive charts, maps, and videos. Last September, video blogs were featured in a four-part series titled “Century Since the Storm”, which looked back at the hurricane that struck North Carolina in 1913. This variety of media provides new ways to access and visualize information.



SCO Twitter Account: Over the past few years, we have been using Twitter to push information to the public regarding SCO products and services, as well as general climate information. Tweets are generated with each blog entry publication, during ECONet station maintenance and SCO outreach events, and as any new and interesting weather and climate events occur. We currently have 257 followers for the SCO Twitter account, @NCSCO, which equates to 116 new followers compared to this time last year. From May 1, 2013 through April 30, 2014:

- 66 of the tweets sent out directly from @NCSCO were “re-tweeted”,
- 25 of our tweets were “favorited”,
- @NCSCO was “mentioned” 69 times in the tweets of other Twitter accounts, and
- @NCSCO was “mentioned” in many tweets that were later “favorite” or “re-tweeted” by followers of other Twitter accounts.



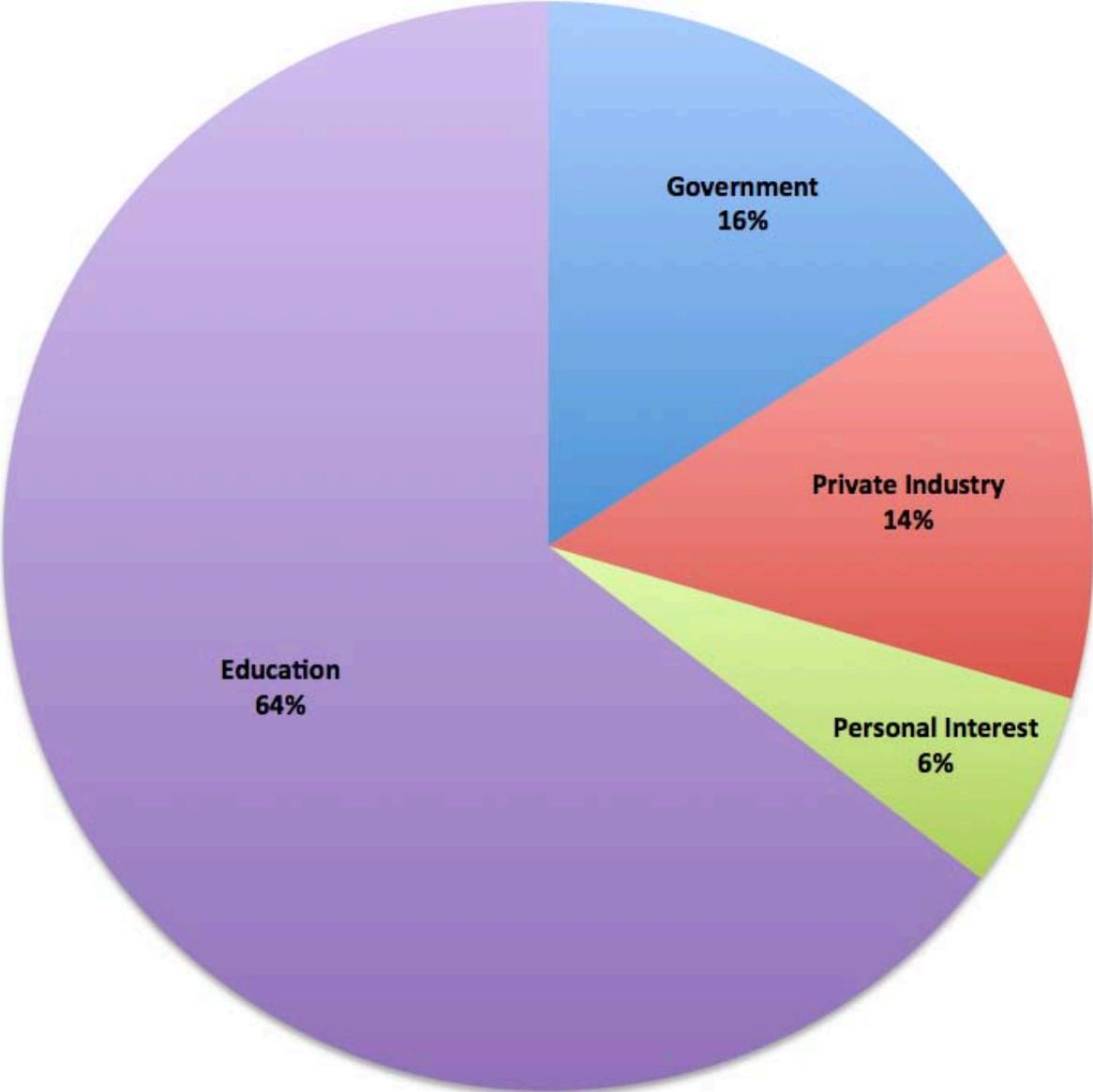
Broadcaster Engagement: Last fall, our office emailed broadcast meteorologists across the state to provide updates about our new and relevant web tools, blog posts and Twitter feed, and climate services. Broadcasters have been an important outlet for sharing blog posts and passing along climate-related questions from viewers, and we plan to continue to broaden our outreach efforts to broadcast meteorologists.

Team: Heather Dinon Aldridge, Corey Davis, Ashley Hiatt, Sean Heuser, Rebecca Cumbie, John McGuire, Adrienne Wootten, Ryan Boyles, and all SCO undergraduates

Appendix A: Climate Services by Client Sector

**Climate Information Services
Effort by Client Sector**

May 1, 2013 through April 30, 2014



Climate Information Services by Client Sector - Details

May 1, 2013 through April 30, 2014

Classification	Number of Requests	Hours Worked
Government: Federal-Agriculture	8	8
Government: Federal-Education: college, university	1	1
Government: Federal-Engineering	1	1
Government: Federal-Other	16	17
Government: Local-Agriculture	1	1
Government: Local-Economic development	6	7
Government: Local-Education: college, university	4	4
Government: Local-Education: K-12	1	1
Government: Local-Energy	1	1
Government: Local-Engineering	2	2
Government: Local-Health	1	1
Government: Local-Library	1	1
Government: Local-Other	9	9
Government: Local-Water	2	2
Government: multijurisdictional-Economic development	1	1
Government: State-Agriculture	2	2
Government: State-Construction	1	1
Government: State-Education: college, university	302	316
Government: State-Education: K-12	1	1
Government: State-Energy	1	1
Government: State-Health	3	4
Government: State-Legal/insurance	2	2
Government: State-Other	20	21
Government: State-Water	3	4
NGO-Tourism/recreation	1	1
Private entity-Agriculture	6	6
Private entity-Construction	2	2
Private entity-Education: college, university	17	26
Private entity-Education: K-12	2	2
Private entity-Energy	1	1
Private entity-Engineering	23	23
Private entity-Legal/insurance	6	6
Private entity-Manufacturing	2	2
Private entity-Media	12	13
Private entity-Other	10	10
Private entity-Personal interest	30	30
Private entity-Water	7	7
Totals	509	538
Percent Change from Previous Year	+1.2%	+2.7%

Appendix B: Simplified Budget

FY2014 Budget (from May 2013 Annual Report)

Source	Personnel	Operating Expenses	Total	Percent
College of Sciences	\$235,010	\$30,000	\$265,010	25%
NC Agriculture Research Service	\$132,787	\$58,000	\$192,385	18%
External Contracts & Grants	\$517,408	\$87,382	\$604,791	57%
Service Center		\$5,000	\$5,000	0%
Total	\$888,208	\$180,882	\$1,069,090	

FY2014 Expenditures

Source	Personnel	Operating Expenses	Total	Percent
College of Sciences	\$227,958	\$58,417	\$286,375	29%
NC Agriculture Research Service	\$134,248	\$60,625	\$194,873	19%
External Contracts & Grants	\$456,908	\$52,027	\$508,935	50%
Service Center	\$219	\$23,374	\$23,593	2%
Total	\$819,333	\$194,443	\$1,013,776	

FY2015 Budget

Source	Personnel	Operating Expenses	Total	Percent
College of Sciences	\$235,010	\$30,000	\$265,010	23%
NC Agriculture Research Service	\$135,790	\$58,500	\$194,290	17%
External Contracts & Grants	\$561,614	\$109,527	\$673,141	60%
Service Center		\$5,000	\$5,000	0%
Total	\$932,414	\$203,027	\$1,137,441	

Appendix C: Impact Statement

State Climate Office of North Carolina

NC State University

The Need

Climate affects many aspects of our daily lives - agriculture, environment, transportation, tourism, and natural disasters to name a few. Nearly one-third of our nation's economic activity is estimated to be sensitive to weather and climate. Scientific discovery and understanding of weather and climate begins with environmental data collection, research and education.

Serving the Need

The State Climate Office (SCO) is a public-service center for climate-environment interactions in North Carolina. The SCO is housed at NC State University in the College of Physical and Mathematical Sciences with support from the NC Agricultural Research Service. The SCO is the primary source for North Carolina weather and climate information and is involved in all aspects of climate research, education, and extension services. Activities include:

- Operate and collect high-resolution weather data from a growing network of 38 research quality weather stations called the Environment and Climate Observing Network (ECONet).
- Disseminate climate information to the citizens and businesses of North Carolina through the CRONOS database, an intuitive website making climate data available from over 20,000 surface weather and water resource stations in and around North Carolina.
- Assist state government agencies in climate adaptation activities that reduce costs and conserve resources.
- Collaborate with extension scientists to provide agricultural guidance to growers for disease management and irrigation, which lead to crop loss mitigation and better production decisions. Drought monitoring and management at community, statewide, and national scales.
- Study climate variations and impacts on North Carolina, including sensor and model evaluation, severe weather patterns, drought and water resource management, and economic impacts.
- Numerous community presentations, science fairs, and other interactions with K-12, college students and teachers.

Impact beyond North Carolina

Undergraduate and graduate students working at the SCO gain a genuinely multi-disciplinary experience that contributes to career growth and lifelong learning. Many successes of the SCO are often heralded as a model for other states' climate offices.