NC STATE UNIVERSITY

State Climate Office of North Carolina
1005 Capability Drive
Centennial Campus Box 7236
Raleigh, NC 27695-7236

Phone: (919) 515-3056
Fax: (919) 515-1441
E-mail: sco@climate.ncsu.edu
Web: www.nc-climate.ncsu.edu

STATE CLIMATE OFFICE OF NORTH CAROLINA

2011-2012 Annual Report

July 5, 2012

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
Assistant State Climatologist

Mr. Mark Brooks
Climate Services Coordinator

Ms. Ashley Hiatt
Environmental Meteorologist

Mr. Sean Heuser
Instrumentation Meteorologist

Mr. John McGuire
Environmental Meteorologist & Developer

Ms. Heather Dinon
Applied Climatologist

Mr. Greg Deleruyelle
Administrative Support Specialist

Ms. Ava Davis
Administrative Support Specialist

Ms. Rebecca Cumbie, Graduate Assistant
Mr. Corey Davis, Graduate Assistant
Ms. Megan Embrey, Graduate Assistant
Ms. Adrienne Wootten, Graduate Assistant

Mr. Colin Craig, Undergraduate Assistant
Ms. Geneva Ely, Undergraduate Assistant
Ms. Torrey Feldman, Undergraduate Assistant
Ms. Melissa Mainhart, Undergraduate Assistant
Mr. James McClellan, Undergraduate Assistant
Mr. Charles O'Connell, Undergraduate Assistant
Mr. Thomas Petersen, Undergraduate Assistant
Mr. Joseph Taylor, Undergraduate Assistant
Ms. Rachel Wrenn, Undergraduate Assistant

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Dr. Walt Robinson, NCSU MEAS
Mr. Tommy Shingleton, Shingleton Farms
Dr. David Smith, NCSU Agricultural Research

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SCO Team, June 2012

Back Row: Heather Dinon, Aaron Sims, Greg Deleruyelle, Adrienne Wootten, Mark Brooks, Charles O'Connell, John McGuire.
Middle Row: Geneva Ely, Ashley Hiatt, Ameenulla Syed, James McCellan, Joe Taylor, Sean Heuser, Ryan Boyles
Front Row: Bradley McLamb, Torrey Feldman, Rebecca Cumbie, Megan Embrey, Colin Craig, Corey Davis

Executive Summary

In the Academic Year 2011-2012, 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 were focused on enhancement of web-based resources, development and delivery of tools and services for agriculture, forestry, natural resource, and water resource sectors. We also continued our programs to support the NOAA SE Regional Climate Center and established a new extension program focused on forests.

Research efforts in the past year built on partnerships with the Southeast Climate Consortium with an emphasis on model development and implementation, radar-based precipitation datasets, and drought monitoring.

Educational outreach activities focused on training for NCSU students, our ongoing partnerships with The Science House and Centennial Campus Middle School, and several large outreach programs that touched thousands of students across the state.

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 colleges teachers and students, and with other community organizations on different aspects of NC climate and environment.

Extension

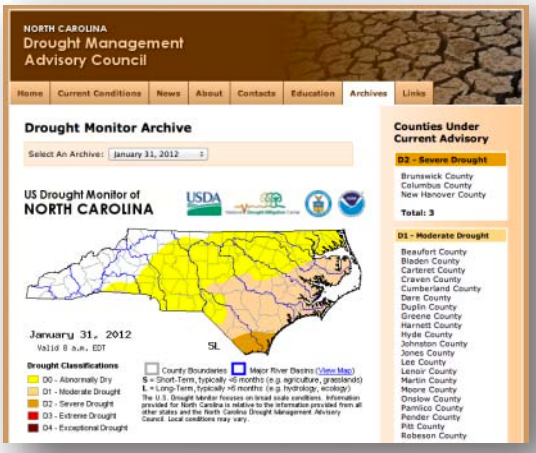
Extension efforts were focused on enhancement of web-based resources, development and delivery of tools and services for agriculture, forestry, natural resource, and water resource sectors. We also continued our programs to support the NOAA SE Regional Climate Center and established a new extension program focused on forests.

Climate Information Services

The primary service of the State Climate Office is to provide scientific and data expertise to clients who request information. 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. Most users are not sure what data or information is best for their needs, and many 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: Interest from clients during 2011-2012 resulted in a **9% decrease** in time spent directly responding to requests for services from clients as compared with the previous year. A large percentage of time is devoted to supporting educational requests (52%), while remaining effort goes largely to support government (19%) and private industry (20%). Formal public interest requests account for 9% of effort. A detailed breakdown of request-driven climate services is provided in Appendix A.

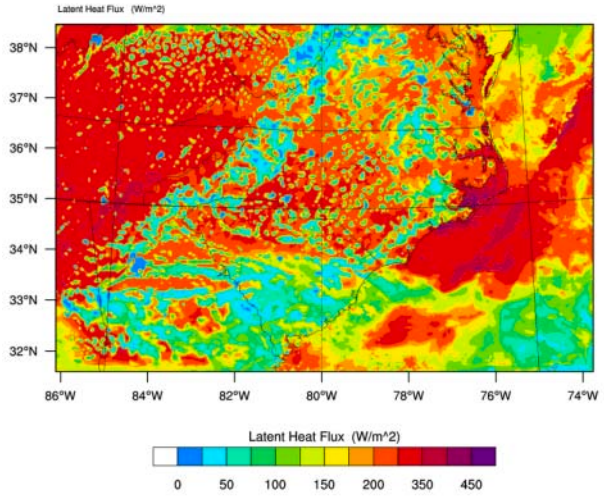
Monthly climate summaries: Climate summary reports are prepared each month to review climate patterns, their causes, and impacts to agriculture and water resources in NC. These are distributed via a monthly online newsletter, reports to NOAA through the Southeast Regional Climate Center (SERCC), through the Southeast Climate Consortium (SECC), and via the SCO's new Twitter feed. The SCO uses the newsletters to also highlight SCO products and services. Currently, monthly climate summaries and news are distributed to hundreds of users via science teacher and agriculture extension email listservers. In addition, 471 individuals have signed up to directly receive these products via email each month.
http://www.nc-climate.ncsu.edu/office/newsletters/



Drought Monitoring and Response: 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. SCO has provided routine updates on drought conditions and impacts through the Drought Management Advisory Committee, monthly climate summaries and newsletters, and interviews for print and broadcast news media.

Environmental Modeling: SCO continues to produce experimental numerical weather forecast guidance using the Weather Research Forecast model. These simulations are available for use by the public, and are distributed to partners including DENR and National Weather Service. Moreover, these simulations provide guidance to support a series of agricultural projects, including peanut disease guidance, the ipmPIPE for cucurbits, and new efforts with smoke dispersion. Improvements in the past year include:



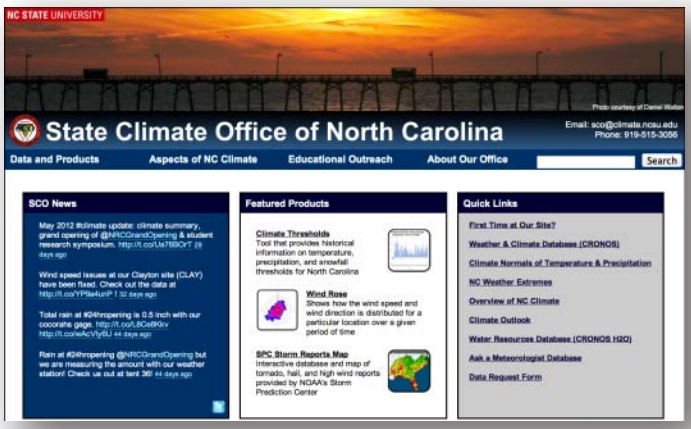
- Implementation of routine modeling statistical evaluation
- Implementation of multiple model versions and configurations to support multiple agricultural and forest projects
- Implementation of new 12km and 4km resolution domains for the eastern US
- Development of new convective output products to support NWS

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: **34% increase** in website activity as measured by the number of unique visitors. The SCO website averages over 33,000 unique visitors every month.

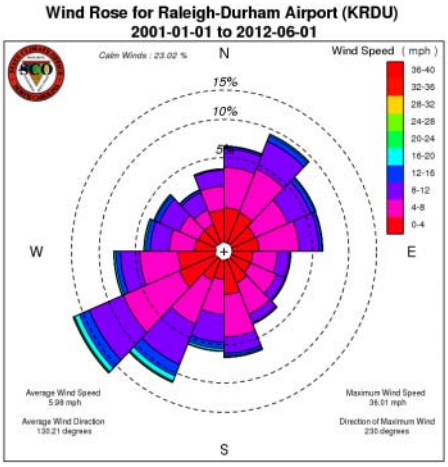
- 56% of traffic comes from searches on search engines (e.g. Google, Bing, etc.)
- 17% of traffic comes from direct hits (e.g. bookmarks, going directly to URL)
- 27% of traffic comes from non-search engine referring sites



New Home Page and Website Design: Our new front page launched on February 2, 2012. New features include:

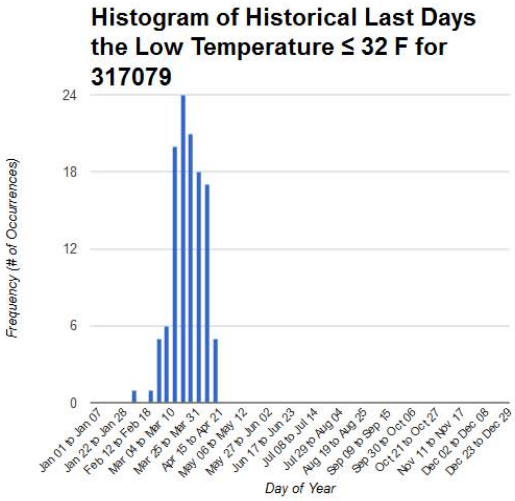
- Mini-CRONOS map on homepage shows current conditions from ECONet sites
- SCO is now on twitter as @NCSCO. Twitter feed is now highlighted on homepage.
- The homepage now includes links for the most popular destinations.
- Link and tools for first time visitors. The "first time at our site" page welcomes new visitors and includes information about how to use our website and find data.
- The entire website uses a new menu hierarchy that enables users to access almost every page immediately.
- The product wheel previously shown on each theme landing page (i.e., Agriculture) is replaced with a product matrix.

White Christmas Tool: Helps users determine the probability of having a White Christmas in their area based on past observations of wintry weather over the holiday season. *Team: Ashley Hiatt, Corey Davis*



Wind Rose Tool: By popular demand, SCO now has a tool that allows users to plot a wind rose to visualize wind frequency distributions for all wind reports in CRONOS. *Team: Megan Embrey, Adrienne Wootten, Ashley Hiatt*

Training videos for SCO products: These short videos provide step-by-step tutorials for some of the SCO's web products. To date, 7 videos have been created for the DOT MPE tool, the Hurricanes Database, the SPC Storm Reports Interactive Map, the Winter Storm Database, the LSR Database, and the First Time at Our Site page focused on website navigation and data retrieval. Additional videos will include an introductory "About the SCO" video; tutorial videos for the Thresholds tool, Climate Perspectives (for the SERCC), the Fire Weather Intelligence Portal, and other web products; and educational content for our website. *Team: Corey Davis, Ashley Hiatt, Mark Brooks*



Climate Thresholds Tool: This tool, released in April 2011, is designed to allow users to determine several different thresholds for a given location. These include average first / last days that high or low temperatures are above or below a user-defined threshold, the average day of first snowfall above a user-defined threshold, and the number of days that precipitation is above a given threshold. The Climate Thresholds Tool also conveys the variability of the first / last days and number of days in the

historical record. *Team: Adrienne Wootten, Mark Brooks*

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 we have. The CRONOS database serves as the foundation for most SCO products and services.

Usage: Average of 4,641 external queries per month to CRONOS, the SCO online climate database. This activity is a decrease of 20% from the previous year.

CRONOS API: An application programming interface (API) continues to be developed to allow authorized users to access CRONOS data without going through the web interface. 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 nearly 2.7 million queries via the API. Improvements over the past year include:

- return for stations by distance from a given lat/long
- return stations by state, county FIPS, or lat/lon bounding box
- listing of nearby stations that are most correlated for minimum and maximum temperature.

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.

Station Maintenance: 45 site visits were made over the past year to perform routine or

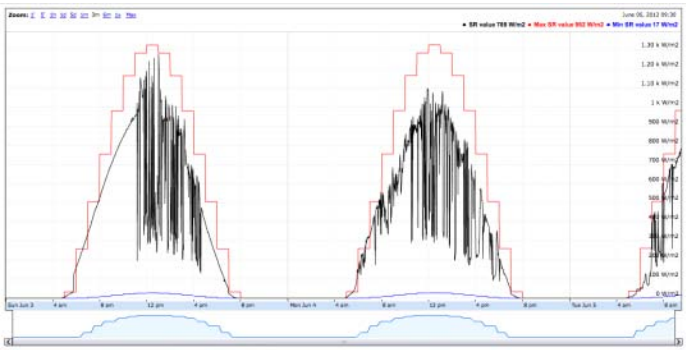
emergency maintenance. The station located at Mt. Mitchell collapsed due to heavy ice and wind in September. The station has been repaired and is back functioning as of early March.

Station Improvements: As part of the routine maintenance, upgraded radiation sensors as well as all-weather sensors were installed at a number of our stations this year in an effort to have a consistent set of instruments at every site. Additional wind sensors at 6-meter heights are being installed as part of the contract with DENR Forest Resources to meet their data collection needs for the National Fire Danger Rating System. Currently, 3 sensors have been deployed for this project with the remaining to be deployed over the next year. In addition, leaf wetness sensors were installed at our 2 sites in Raleigh to help gather more data.

Mount Mitchell: Last year, with the assistance of DAQ, an experimental station was installed on top of the museum at Mt. Mitchell State Park. After analyzing the data, the evidence suggests that winds at the permanent tower (near the ranger residence) are similar to winds at the summit of the mountain. Wind speeds, on average, are greater at the permanent site, which is most likely due to the funneling of the winds down the mountain. The experimental site is continuing to record data throughout this year.

Station Communication: Radio-based communications using the State Highway Patrol are underway. A preliminary test of this process was successful, and communication hardware has been installed at the Garner Highway Patrol communications tower. This base station will allow for improved data communication with 3-4 ECONet stations, and reduce long-term communication costs while increasing communication reliability.

Data Quality Control: Large strides were taken this year in regards to the SCO in-house QA/QC procedures. New tests were implemented to check for inconsistencies based on the ratio between photosynthetically active radiation and total incoming solar radiation. Another radiation test that checks for sensor drift has been tested and run for historical data. Precipitation comparison checks have been implemented to compare values between the tipping bucket rain gauge, the Vaisala WXT 520 all-weather sensor, and the Multi-sensor Precipitation Estimate (MPE). A test for identifying large changes in values with time has been implemented for temperature. Currently, other types of checks are being tested to look for spikes in data for wind speed and barometric pressure. A minimum variability check is in the very early stages of development. This check will be used to test for variability in values over a given period (usually 60 minutes).



Planned Installations: Due to the new AWOS station at Siler City Airport, SCO is working with DENR to move the SILR ECONet station to the peak of Mount Jefferson State Natural Area. Current contacts with another site in Hyde County by Lake Mattamuskeet have proven unsuccessful but an alternative site in Hyde County has been located. Site visits and planned installations are scheduled for the next year. Due to the physical environment surrounding the ECONet station in Boone, NC, we are working with Dr. Baker Perry at Appalachian State University to identify other high elevation sites that could best support those sensors.

Participation with National Mesonet: As part of the NOAA effort to establish linkages with all local mesonets, the SCO was included in a proposal with Coastal Carolina University and GST, Inc to establish MesoUS in support of the National Mesonet. As part of the MesoUS effort, SCO provides all routine observations to the MADIS gateway used by NOAA. In addition, SCO is working toward an in-the-field metadata management system that will enable technicians to digitally update metadata, take photos, and log station visit activities using mobile devices.

Soil Sensor Experiments: With the guidance of Dr. Josh Heitman (NCSU Soil Science), an experimental station for soil sensors, radiation sensors, and leaf wetness sensors was installed on October 1, 2011 at the Lake Wheeler Rd site in Raleigh. The goal is to monitor soil sensors under different land use characteristics in an effort to standardize the land use and vegetation around the ECONet sensors.

Team: Sean Heuser, Ameenulla Syed, Aaron Sims, John McGuire, with contributions from all staff and students

Climate Support for Agriculture

SCO has developed a successful record of working with agriculture researchers and extension specialists to develop weather-based decision tools. Below are highlights from our agricultural support efforts:

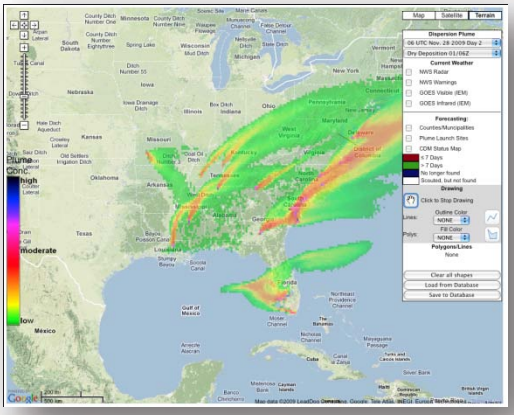
Updates to Blackberry Chill Model: The Blackberry Chill Model generates chilling units for various locations based on observed temperatures, helping determine when rest completion will occur. An update was made to the blackberry chill model page to account for later-than-expected inception dates at various locations. *Team: Ashley Hiatt*

Peanut Disease Advisories: Working Dr. Barbara Shew (NCSU Plant Pathology), SCO provided daily guidance for fungicide spraying to peanut growers in NC from June-October. These advisories take advantage of research into the relationships between climate and the development of two peanut fungal diseases. In 2011, SCO will begin its 8th year of collaborating with Dr. Shew to provide these advisories. *Team: John McGuire, Mark Brooks, Aaron Sims*

Turfgrass Disease: The Center for Turfgrass Environmental Research and Education funded SCO to develop a turf disease alert system in partnership with Dr. Lane Treadway (Plant Pathology). The system is being beta tested by 8 golf course superintendents during the summer of 2012. *Team: Corey Davis, Colin Craig, Mark Brooks.*

Climate Information for Thrips Risk Assessment: In collaboration with Drs. George Kennedy, Hannah Burrack, and Thomas Chappell (NCSU Entomology), 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) that 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. SCO is also working with Dr. Asimina Mila (NCSU Plant Pathology) to develop a pre-season TSWV risk map based on her research using temperature, precipitation, and disease incidence per county. SCO has developed a gridded product showing risk based on her formulas, PRISM estimates of temperature, and the Multi-sensor Precipitation Estimates. *Team: Rebecca Cumbie, Mark Brooks, Ashley Hiatt, Aaron Sims*

Cucurbit Downy Mildew Forecasts: In collaboration with Dr. Peter Ojiambo, Mr. Thomas Keever, and Ms. Wendy Britton (NCSU Plant Pathology), NCSU continues 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 is responsible for providing weather information, technology support, and dispersion forecast guidance. During the 2011 growing season cdm.ipmpipe.org averaged 700-1000 unique visitors each month. There were 187 confirmed reports of cucurbit downy mildew during that period. While the formal USDA project has ended, SCO continues to work with partners in NCSU Plant Pathology to maintain the cdm.ipmpipe.org site and forecasting tools, and have received funding to maintain core services for the next



year. *Team: John McGuire, Mark Brooks, Aaron Sims, Ryan Boyles*

Tobacco Blue Mold Support: In collaboration with Dr. Asimina Mila (NCSU Plant Pathology), SCO is providing IT support for the tobacco bluemold reporting and forecast website. *Team: John McGuire, Mark Brooks*

Late Blight for Potatoes and Tomatoes: In collaboration with Dr. Jean Ristaino (NCSU Plant Pathology), NCSU in 2010 joined a team of plant pathologists to successfully propose development of a national monitoring and alert tool for Late Blight that affects tomatoes and potatoes. SCO is responsible for providing weather information and technology support based on effort and experience with the Cucurbit Downy Mildew project. This is a 5-year project funded by USDA National Institute for Food and Agriculture. *Team: John McGuire, Mark Brooks, Aaron Sims, Ryan Boyles*

Climate Support for Forest and Natural Resource Management

In the past 2 years, SCO has successfully proposed projects to support forest and natural resource management, including extension activities to support production forestry and fire weather monitoring.

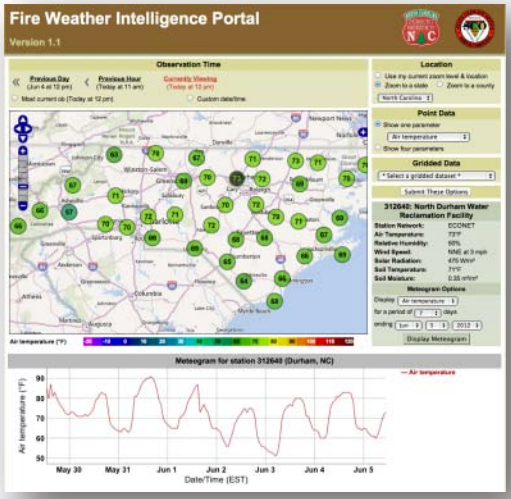
PINEMAP(Pine Integrated Network: Education, Mitigation, & Adaptation Project): Climate Support for Southern Conifer Management: In collaboration with 42 other investigators from across NC State University and the southern US, SCO successfully proposed in 2010 a 5-year project to USDA for research, extension,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

- Revision of online climate education materials for forestry sector
- Introduction of forestry extension partners to southern State Climatologists through a national conference and a series of phone conferences
- Working with partners in the multi-state Southeast Climate Consortium and other PINEMAP colleagues to plan the Decision Support System (DSS)
- Development of 5 fact sheets that translate PINEMAP research topics to landowners:
    - *Glossary of Climate Terms*
    - *Assessing Forest Vulnerability*
    - *Southern U.S. Drought*

    - *Climate Oscillations: Impacts to Forestry*
    - *Introduction to Weather and Climate*
- Assistance with a PINEMAP webinar series to promote understanding of climate science and collaboration and knowledge sharing among the interdisciplinary PINEMAP team. Seven webinars were conducted with a total of 171 participants

- Providing input to Association of Natural Resources Extension Professionals (ANREP) Climate Science Initiative and presenting at the Biannual ANREP Conference in May 2012
- *Team: Heather Dinon, Ryan Boyles*

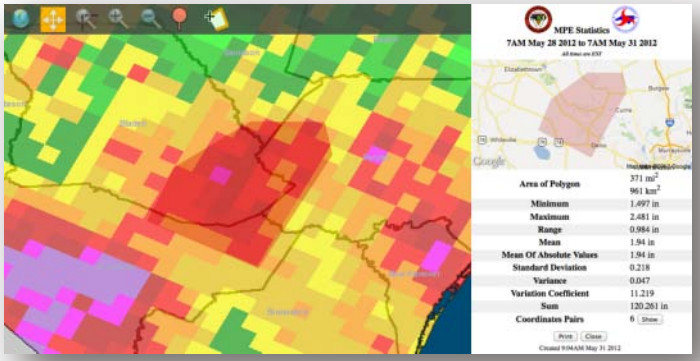
Fire Weather and Smoke Guidance: After nearly a decade of discussions with DENR Forest Resources, SCO was awarded a contract to improve the use of weather and climate observations for fire danger monitoring and risk assessment. As part of this effort over the next year, SCO will develop tabular and map-based web tools to visualize fire risk measurements using the National Fire Danger Rating System and inputs from all CRONOS observations and MPE. In addition, SCO will test a preliminary tool to provide improved smoke dispersion guidance based on previous research and effort on the ipmPIPE for Cucurbits. SCO will also deploy additional wind sensors on ECONet stations at a height of 6 meters above ground to meeting NFDRS standards. *Team: Corey Davis, John McGuire, Aaron Sims, Mark Brooks, Ashley Hiatt, Ryan Boyles*



Climate Decision Tools for Water Resources

Like agriculture, SCO has been developing partnerships with scientists and practitioners in the water resource management sectors. Below are highlights from our agricultural support efforts:

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 791 user accounts for this product with 1,173 individual sites monitored. This partnership with NC DOT has received 3 state and national awards. *Team: Mark Brooks, John McGuire, Aaron Sims, Ashley Hiatt, Ryan Boyles*



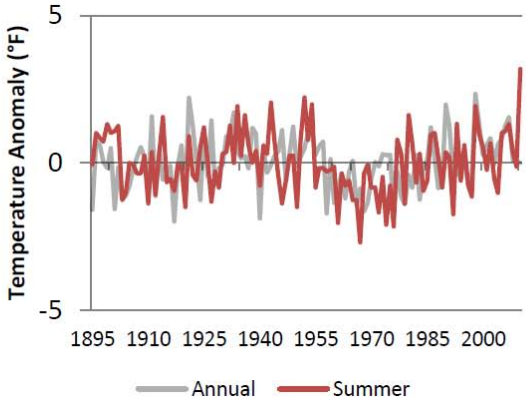
Experimental Inflow Forecasts: In collaboration with Dr. Sankar Arumugam (NCSU Civil, Construction, and Environmental Engineering), SCO developed a web portal to visualize experimental seasonal inflow forecasts using methods developed by Sankar Arumugam. With funding from the NC Water Resources Research Institute and the Urban Water Consortium, SCO focused this past year on monthly operational implementation of seasonal forecasts for reservoir inflow and storage. *Team: Thomas Peterson, Mark Brooks, Ashley Hiatt, Ryan Boyles*

NOAA Southeast Regional Climate Center

NCSU and UNC-Chapel Hill were awarded the NOAA Southeast Regional Climate Center (SERCC) in 2007. As part of that award, the SCO is responsible for supporting and maintaining the Applied Climate Information System (ACIS), which serves as the climate database for all six NOAA Regional Climate Centers. Additionally, SCO is responsible for developing and maintaining the SERCC web services and online climate tools. A new 3-year contract began in 2010 in collaboration with Dr. Charles Konrad (UNC-CH Geography).

Climate Perspectives: Over the past year, SCO has provided operational support for ACIS and the SERCC website. SCO has successfully enhanced the Climate Perspectives tool to provide national coverage in support of the 5 other NOAA regional climate centers.

National Climate Assessment: SCO helped analyze regional climate variability and trends, temperature and precipitation extremes, agricultural and hydrological drought, and severe weather reports for the southeastern United States. This effort was in support of the SERCC's lead effort for the southeast regional climatology chapter in the upcoming National Climate Assessment report.



Climate and Public Health: SCO is working with SERCC partners to connect emergency department visits to climate variables. This is a new effort that will involve exploratory research but eventually lead to a public health surveillance tool for NC.

Team: John McGuire, Ashley Hiatt, Mark Brooks, Aaron Sims, Ryan Boyles

DOI Climate Science Center

In collaboration with 14 other investigators at NC State University, SCO successfully proposed and established the US Department of Interior's SE Climate Science Center at NC State University. Establishment of this new center provides a range of new opportunities for collaboration with university, government, and non-profit agencies to research and manage the impacts of climate on wildlife resources in the southeastern US. In the past year, SCO has participated in regular meetings with NCSU PIs and other regional DOI Climate Science Centers. In the spring of 2012, SCO successfully proposed development of a synthesis report on climate downscaling products for the southeastern US. *Team: Adrienne Wootten, Heather Dinon, Ryan Boyles*

Applied Research

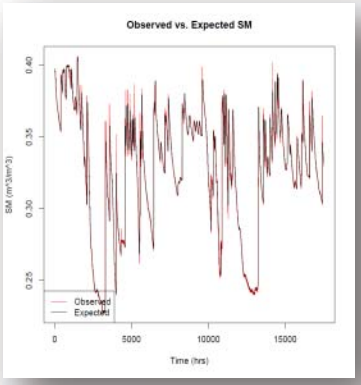
Research efforts in the past year built on partnerships with the Southeast Climate Consortium with an emphasis on model development and implementation, radar-based precipitation datasets, and drought monitoring.

Presentations and Publications

- 3 manuscripts were successfully published in peer-reviewed journals
- 6 manuscripts are in development or currently in submission
- 23 presentations were given at 10 scientific conferences
- 14 staff and students attended 12 scientific meetings and conferences
- SCO students won 3 out of 4 awards presented at the 19th AMS Conference on Applied Climatology

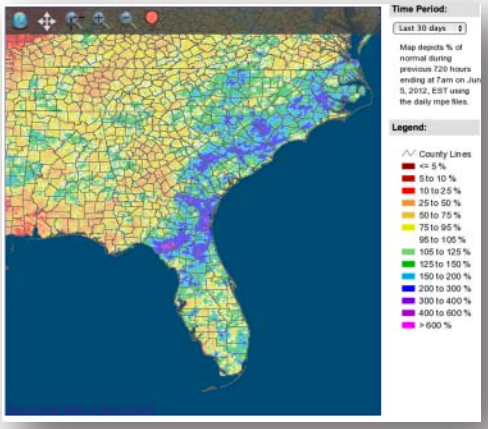
Soybean Flowering and Production: To help determine the impacts of heat stress on soybean flowering and production, data files were generated containing the average number of days with maximum and minimum temperatures above given thresholds – both consecutively and overall – which were thereafter depicted graphically in a GIS. *Team: Ashley Hiatt, Ryan Boyles*

Predicting observed soil moisture using statistical modeling: In order to improve quality control of ECONet soil moisture data, and prediction of missing data, a statistical ARIMA model has been developed to predict an observed value. In the future, the model will be made operational to help with quality control of observed soil moisture data. This research received awards both from the NCSU Undergraduate Research Symposium and Sigma Xi. *Team: Joseph Taylor, Adrienne Wootten, Sean Heuser, and Ryan Boyles*.



Development of a Q2 Climatology for NCDC: Based on previous research on MPE and collaborations with NSSL and National Climatic Data Center (NCDC), SCO proposed and was awarded funds in 2010 through the NOAA Cooperative Institute for Climate and Satellites (CICS) to start development of a radar-based precipitation climatology using NSSL's 2nd generation precipitation estimation technique, called Q2. Q2 provides very high-resolution (1 km spatial, 5 minute temporal) estimates of rainfall using a combination of radar, models, and surface observations. In the past year the data for the pilot domain has been generated for the period 1998-2010 and compared against the NSSL products. Due to funding limits at NCDC, this project will continue on a partial support basis. Collaborators are Scott Stevens (CICS), Brian Nelson (NCDC) and Ken Howard (NSSL).

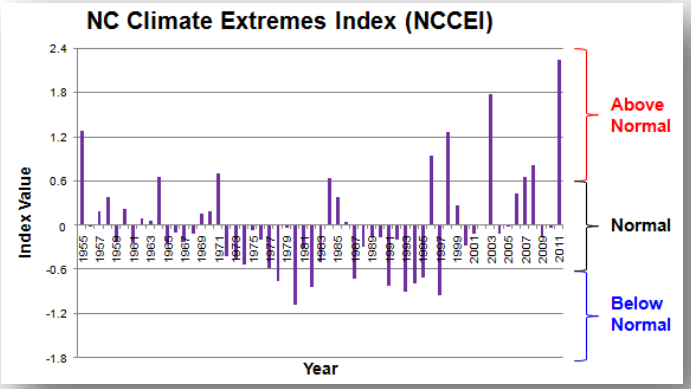
USDA High-Resolution Drought Triggers: Most drought products that exist today are county-level at their finest resolution or are based on interpolated rain gauge data. A Standardized Precipitation Index (SPI) algorithm that uses Multi-sensor Precipitation Estimates (MPE) in its calculation was developed 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. Over the past year, software routines have been developed and we expect beta-testing with partners during the summer of 2012. In 2013, we plan to work with Cooperative Extension to link local estimates of SPI generated by this effort to field impacts in corn, soybeans, and pastures. Collaborators are John Nielsen-Gammon (TAMU) and Dev Niyogi (Purdue). *Team: Rebecca Cumbie, Ryan Boyles*



RENCI Lightning Network Collaboration: SCO completed a study comparing RENCI lightning sensors with the US Precision Lightning Network. Results showed substantial problems with RENCI lightning estimates, and conclude that these estimates are not yet appropriate for lightning monitoring, research, or decision making purposes. *Team: Corey Davis, Ryan Boyles*

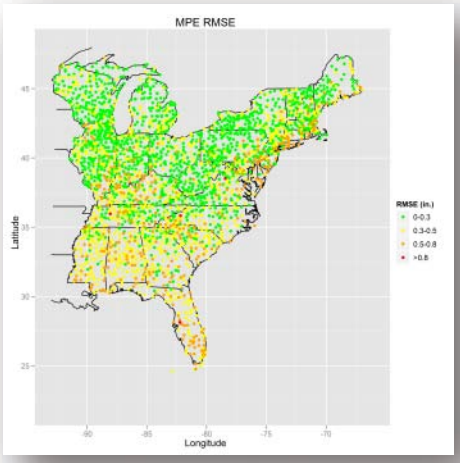
Model Reanalysis / Model Climatology: As numerical weather models improve they may be able to better estimate current and historical climate conditions. SCO is testing several data assimilation schemes to see how well the WRF model can initialize and simulate temperature, moisture, and winds near the surface in complex terrain as compared to surface observations from sensors. If successful, this effort could allow for a very high-resolution (1km) estimate of past climate conditions and model-based climatologies. *Team: John McGuire, Aaron Sims, Ryan Boyles*

Localized Climate Extremes Index: The National Climatic Data Center produces a Climate Extremes Index for the United States that describes the impact of temperature and precipitation extremes on the U.S. from year to year. The goal of this project is to develop a localized version of the Climate Extremes Index that also includes severe weather events, winter weather events, and tropical activity. This localized index will also be flexibly crafted to allow for adaptation for other states. Currently the index methodology has been calculated and evaluated for North Carolina and currently is being evaluated for Florida by the Florida



Climate Center. A second goal of this project is to allow for an objective comparison between years given that multiple extremes may impact the state in a given year, such as in 2011. Collaborators are Melissa Griffin and David Zierden at the Florida Climate Center. *Team: Adrienne Wootten, Ryan Boyles*

Evaluation of Multi-Sensor Precipitation Estimates (MPE): SCO uses MPE products provided by NWS River Forecast Centers and the National Center for Environmental Prediction 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 MPE across the eastern United States (2001-2011), and is preparing a manuscript for weather analysis and forecasting. Future research in this area will involve a comparison with Q2 precipitation estimates in the Carolinas. *Team: Adrienne Wootten, Scott Stevens, Ryan Boyles*

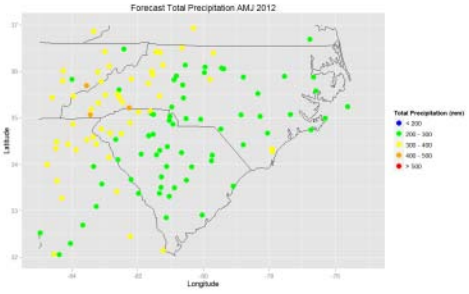


Southeast Climate Consortium (SECC): The Southeast Climate Consortium is a group of Universities in FL, AL, GA, NC, and SC working to develop climate risk research and decision support tools for agriculture in the southeastern US. Funding for the SECC is provided through USDA RMA, NOAA Climate Program Office, and a congressional earmark (primary funding source). NCSU was invited into this Consortium in 2008. This effort has research, education, and extension components. Research in the past years focused on missing data and climate forecasting:

- **Missing Data Challenge:** A Missing Data Working Group was established to create standard methods for estimating missing / erroneous data for SECC. The chosen methods for estimating missing values will be based on best methods suggested in literature, and from evaluation by the project team where necessary. Available datasets will also be used to provide estimates for missing data where appropriate. Daily parameters critical to crop modeling and AgroClimate applications will be the initial focus: minimum and maximum temperature, precipitation, and solar radiation.

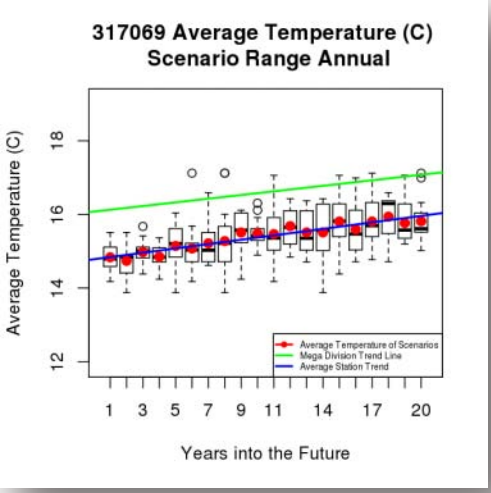
- **Open AgroClimate Reference Et:** Implementation of a decision support tool for estimating reference evapotranspiration into the open source decision system called Open AgroClimate.

- **Evaluation / Implementation of Geospatial Downscaling of Precipitation in the Southeast US:** Working with Dr. Guillermo Baigorria at the University of Florida, SCO is implementing and evaluating a technique to provide advanced geospatial downscaling for seasonal and climate change forecasts over the southeastern US. Results of the evaluation suggest that the basic technique



underestimates extreme precipitation events and the variability associated with tropical precipitation. This technique has been improved to better simulate extreme events. An evaluation reveals that this improved technique more accurately represents extremes events but overestimates precipitation in general. Both techniques have been successfully adapted and evaluated for seasonal forecasting downscaling of precipitation with the Climate Forecast System model. Research on this project has resulted in 2 manuscripts in preparation. A web tool is currently in development for the visualization of experimental seasonal forecasts produced using the downscaling techniques previously tested. Experimental forecast downscaling will be released by end of summer 2012.

- **Development of Historical Climate Analog Scenarios:** Working with Dr. John Christy (University of Alabama – Huntsville), the SCO is developing historical climate analog scenarios to represent the possible future scenarios of temperature and precipitation at local scales in the next 20 years given prescribed larger scale trends in temperature and precipitation based on climate change projections. This method has been built into a prototype web tool that provides historical climate analog scenario information for actively recording stations with at least 50 years of records in the Southeast US. This method is currently being tested for other locations in the continental US. This effort will include preparation of a manuscript in autumn 2012.



Team: Adrienne Wootten, Heather Dinon, Ryan Boyles

Educational Outreach

Educational outreach activities focused on training for NCSU students, our ongoing partnerships with The Science House and Centennial Campus Middle School, and several large outreach programs that touched hundreds of students across the state.

Undergraduate & Graduate Student Training

- SCO supported 9 undergraduate and 4 graduate students over the past year.
- Ms. Adrienne Wootten successfully completed Masters of Science degree in December 2011 and continues to work with the SCO as a PhD candidate.

Invited Presentations and Visitor Programs

- Total Direct Educational Outreach Contact Hours: 50,895
- SCO staff provided 6 presentations by invitation, including large group presentations to Centennial Campus Middle School, StormFest, and the opening of the Nature Research Center.
- SCO provided tours and programs for 10 visitor groups

Newsletter: The SCO's monthly newsletter, *North Carolina Climate*, informs users about new products and services, and includes a monthly climate summary to highlight climate patterns as well as any impacts to agriculture and water resources.

Twitter: In July 2011, an SCO Twitter account was set up to improve communications with the wider public regarding SCO products and services, as well as general climate information. Twitter is used to promote the monthly newsletters and to inform followers about relevant weather events with a climate perspective.

Centennial Campus Magnet Middle School Internship: SCO hosted four 8th grade student interns from Centennial Campus Magnet Middle School (CCMMS) from mid-October 2011 through early April 2012. This is the 9th year of the internship program, where students spend an afternoon every week in the SCO to learn about NC climate and develop their own research projects. *Team: Ashley Hiatt, Adrienne Wootten, Megan Embrey, Heather Dinon, Ryan Boyles*

NC Science Olympiad (NCSO): NC Science Olympiad is an annual science contest for middle and high school students held on North

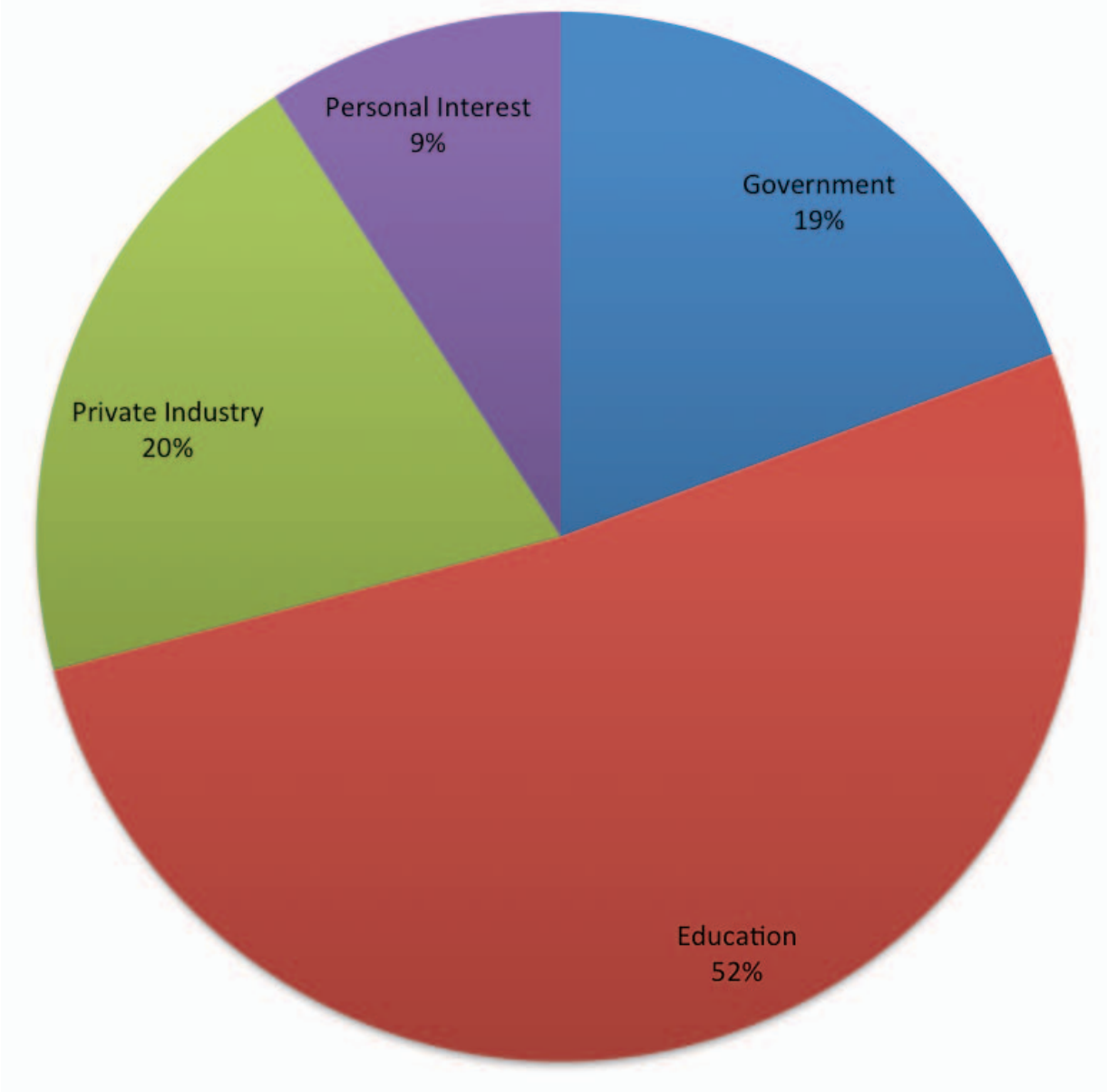
Carolina State University's campus. SCO led a coach's workshop and hosted the weather event for the NCSO State Tournament. *Team: Megan Embrey, Ashley Hiatt, Adrienne Wootten, Sean Heuser, Joe Taylor, Heather Dinon, Corey Davis*

Science House Partnership: SCO continues to work with The Science House at NC State University to improve its educational outreach efforts. In the past year, this partnership enabled joint support for a graduate student (Megan Embrey) and SCO participation in several educational conferences and teacher training programs. *Team: Megan Embrey, Heather Dinon, Ashley Hiatt, Ryan Boyles*

Climate Education Modules: SCO has designed, developed, and maintains a series of web-based climate education modules for agricultural clients and K-12 educators. This is currently being expanded to support education for water resource managers, natural resource and forestry practitioners, and public health officials. Such modules are created in hopes to improve basic understanding of climate science, including climate variability and climate change, across North Carolina and the Southeast. Partners include Pam Knox (UGa) and Mark Megalos (NCSU Forestry and Environmental Resources). *Team: Megan Embrey, Ashley Hiatt, Heather Dinon, Ryan Boyles*

Appendix A: Climate Services by Client Sector

Climate Information Services
Effort by Client Sector
April 1, 2011 – May 20, 2012



Climate Information Services by Client Sector - Details

April 1, 2011 – May 20, 2012

Classification	Number of Requests	Hours Worked
Government: Federal-Agriculture	8	8
Government: Federal-Education: college, university	1	1
Government: Federal-Engineering	2	2
Government: Federal-Health	1	1
Government: Federal-Other	27	28
Government: Federal-Water	1	1
Government: Local-Agriculture	1	1
Government: Local-Economic development	1	1
Government: Local-Education: college, university	1	1
Government: Local-Education: K-12	2	2
Government: Local-Engineering	2	2
Government: Local-Other	9	9
Government: Local-Water	12	12
Government: multijurisdictional-Other	1	1
Government: State-Agriculture	6	6
Government: State-Construction	13	14
Government: State-Education: college, university	326	346
Government: State-Education: K-12	2	2
Government: State-Engineering	2	2
Government: State-Health	3	5
Government: State-Legal/insurance	3	3
Government: State-Other	24	24
Government: State-Personal interest	2	2
Government: State-Water	15	16
NGO-Water	1	1
Private entity-Agriculture	9	11
Private entity-Construction	15	15
Private entity-Economic development	3	3
Private entity-Education: college, university	13	14
Private entity-Energy	7	8
Private entity-Engineering	27	27
Private entity-Legal/insurance	28	28
Private entity-Manufacturing	2	2
Private entity-Media	14	14
Private entity-Other	24	24
Private entity-Personal interest	61	63
Private entity-Water	8	8
Total	677	708
Percent Change from previous year	-9%	-9%

Appendix B: Simplified Budget

FY2012 Expected Budget (from May 2011)

Source	Personnel	Operating Expenses	Total	Percent
College of Physical & Mathematical Sciences	$225,869	$30,000	$254,869	25%
NC Agriculture Research Service	$134,385	$58,000	$192,385	19%
External Contracts & Grants	$471,932	$90,227	$562,159	55%
Service Center		$5,000	$5,000	0%
Total	**$830,454**	**$183,227**	**$1,013,681**	

FY2012 Expenditures

Source	Personnel	Operating Expenses	Total	Percent
College of Physical & Mathematical Sciences	$165,613	$90,373	$255,986	25%
NC Agriculture Research Service	$133,232	$56,945	$190,177	19%
External Contracts & Grants	$454,943	$98,331	$553,274	54%
Service Center	$7,287	$14,553	$21,840	2%
Total	**$761,075**	**$260,202**	**$1,021,277**	

FY2013 Expected Budget

Source	Personnel	Operating Expenses	Total	Percent
College of Physical & Mathematical Sciences	$225,869	$30,000	$254.869	23%
NC Agriculture Research Service	$132,787	$58,000	$192,385	17%
External Contracts & Grants	$599,516	$72,058	$671,574	59%
Service Center		$5,000	$5,000	0%
Total	**$969,746**	**$165,058**	**$1,134,804**	

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 37 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.