

STATE CLIMATE OFFICE OF NORTH CAROLINA



2010-2011 Annual Report

May 30, 2011

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.

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Executive Summary

In the Academic Year 2010-2011, the State Climate Office continued its efforts to deliver climate information, climate data, and climate services to the state of North Carolina.

Extension efforts were focused on delivery of services through direct interaction and communication with clients, partnerships with state agencies, and collaboration with extension specialists and scientists at NC State University. Significant extension activities in 2010-2011 include development of several new web-tools, improvements to the climate database, development and deployment of agricultural tools with research partners, and improvements to the NC ECONet.

Research efforts in the past year focused on the study of North Carolina's climate and its interaction with the environment. Specific activities include model improvements, analysis of radar-based precipitation, impacts of climate patterns on NC weather and SE agriculture, and analysis of advanced downscaling methods.

Educational outreach activities in the State Climate Office are designed so that climate scientists interact with K-12, college teachers and students, and with other community organizations on different aspects of NC climate and environment. Specific activities include undergraduate and graduate student training, middle school internships, and contributions to the NC Science Olympiad and NOAA Hurricane Awareness Tour.

Extension

Extension efforts were focused on delivery of services through direct interaction and communication with clients, partnerships with state agencies, and collaboration with extension specialists and scientists at NC State University. Significant extension activities in 2010-2011 include development of several new web-tools, improvements to the climate database, development and deployment of agricultural tools with research partners, and improvements to the NC ECONet.

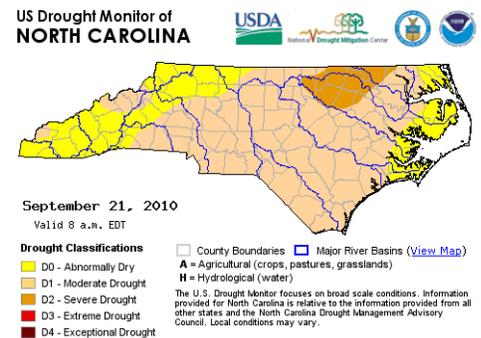
Climate Information Services

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.

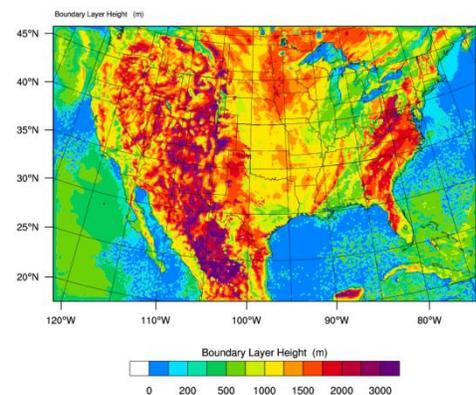
- **Requests for Services:** Interest from clients during 2010-2011 resulted in a **12% increase** in time spent directly responding to requests for services from clients as compared with the previous year. Clients request services via email, phone, and through the Climate Office website. A large percentage of time is devoted to supporting requests from faculty, staff, and students at Universities. 58% of time for requested services was in response to Universities, with 44% of all time supporting requests from within the UNC system, which is a 5-10% increase in effort as compared to previous years. A more detailed breakdown of request-driven climate services is provided in Appendix A.
- **Monthly climate summaries:** Climate summary reports are prepared each month to highlight climate patterns 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), and through the Southeast Climate Consortium's (SECC) AgroClimate.org resource. The SCO uses the newsletters to also inform users about SCO products and services. Currently, monthly climate summaries and news is distributed to hundreds of users using science teacher and agriculture extension email listservers. In addition, 416 individuals have signed up to directly receive these products via email each month.
 - <http://www.nc-climate.ncsu.edu/office/newsletters/>
- **NCDA Monitoring:** NC Department of Agriculture receives a feed of climate data from the SCO to develop their weekly weather and crop status reports. Weekly temperature, precipitation, and degree day accumulations are

provided for dozens of sites across the state. A map of precipitation accumulation based on radar estimates is also provided. These data are distributed to all recipients of the USDA weekly weather and crop reports.

- 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. Drought monitoring products have been developed and are used each week for discussions on depictions of drought severity as part of communicated recommendations to the US Drought Monitor. Drought has been present in NC to some extent since the summer of 2010, and the 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 RENCi 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.

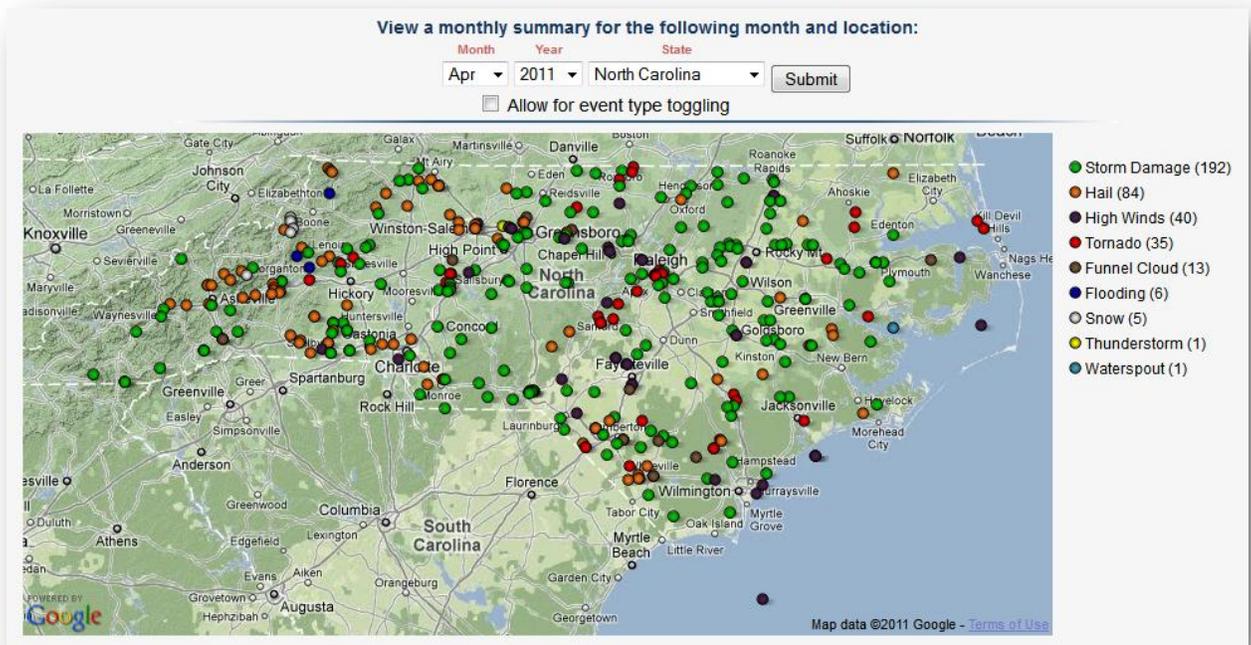


Website

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: 25% increase** in website activity as measured by the number of unique visitors. The SCO website averages over 20,000 unique visitors every month. Other measure of website activity such as bandwidth and hit counts are available but may be biased by the increase in the number of pages and content added to the site over the past year.
 - 48% of traffic comes from searches on search engines (i.e., Google, Yahoo, etc.)
 - 19% of traffic comes from direct hits (i.e., bookmarks, going directly to the URL)

- 33% of traffic comes from non-search engine referring sites.
- **Computing Improvements:** Web services are now more robust through the use of redundant web and database servers which load balance and replicate the information.
 - *Team: Bryan Aldridge, Aaron Sims, John McGuire, Mark Brooks.*
- **Local Storm Reports Database:** This new web tool provides a searchable archive of Local Storm Reports (LSRs) issued by National Weather Service offices across the country, which includes the ability to filter by date, location and event type. This product has been used to aid users in identifying possible storm events that caused property damage, and has been used internally when creating monthly climate summaries.



- <http://www.nc-climate.ncsu.edu/lsrcdb/>
- *Team: Corey Davis, Mark Brooks, and Ashley Frazier*
- **Tropical Precipitation Statistics:** This addition to the tropical cyclone pages provides a breakdown of precipitation from tropical storm events in North Carolina, based on a detailed storm-by-storm analysis over the past 30 years. Users can view the contribution of tropical storm precipitation to the annual and warm-season totals, with map products, graphs, and data tables available to display output.
 - http://www.nc-climate.ncsu.edu/climate/hurricanes/precip_stats.php
 - *Team includes Dan McKemy, Corey Davis, and Ashley Frazier*

- Weather Extremes:** A dynamic web product provides weather extremes for a given region (among the entire state, climate divisions, counties and weather stations) and a given time period (among all-time data, a specific month, and a specific day). This includes up to five events for each extreme, along with a map product showing the most extreme events on a state and climate division level. This tool replaces the older Statewide Extremes page, which only included all-time extremes on a state level.

All-time statewide extremes
Data available from Jan 1, 1870 to May 24, 2011

Event	Location	Date
Highest Temperature View the top five events	110°F** Fayetteville, Cumberland County	Aug 21, 1983
Lowest Temperature View the top five events	-34°F Mount Mitchell, Yancey County	Jan 21, 1985
Greatest One-Day Precipitation View the top five events	21.15 in. Highlands, Macon County	Jul 29, 1879
Greatest One-Day Snowfall View the top five events	36.0 in. Mount Mitchell, Yancey County	Mar 13, 1993
Greatest 24-Hour Rainfall	22.22 in. Altapass, Mitchell County	Jul 15-16, 1916
Greatest Single Storm Snowfall	60.0 in.** Newfound Gap, Swain County	Apr 2-6, 1987 (unofficial)
	50.0 in. Mount Mitchell, Yancey County	Mar 12-14, 1993 (official)
Greatest Precipitation in One Calendar Year	129.60 in. Rosman, Transylvania County	1964
Least Precipitation in One Calendar Year	22.69 in. Mount Airy, Surry County	1930
Warmest Weather Station* View the top five stations	63.8°F Willard, Pender County	annual average
Coldest Weather Station* View the top five stations	43.8°F Mount Mitchell, Yancey County	annual average
Wettest Weather Station* View the top five stations	91.72 in. Lake Toxaway, Transylvania County	annual average
Driest Weather Station* View the top five stations	37.32 in. Asheville, Buncombe County	annual average

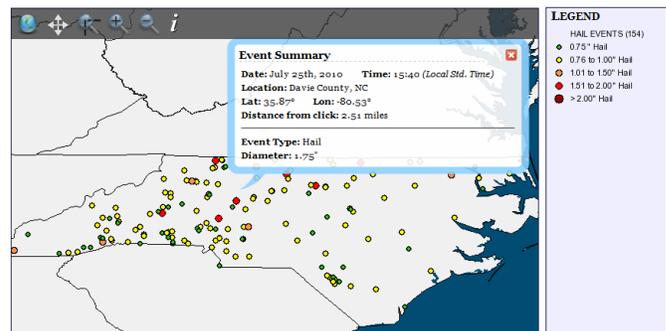
* Based on 1971-2000 climate normals
** Obtained from NWS Raleigh public statement on March 2, 1988

- http://www.nc-climate.ncsu.edu/climate/nc_extremes.php
 - Team: Corey Davis, Mark Brooks*

- Global Climate Patterns:** A new series of educational pages were created to explain the influences of global climate patterns (such as ENSO, AO/NAO, PNA, and PDO) on seasonal and long-term climate variability across the Southeastern U.S. The pages include detailed explanations of each pattern, along with examples of past cases and the resultant effects on North Carolina and the Southeastern U.S. Additionally, interactions between the individual patterns are examined.

- <http://www.nc-climate.ncsu.edu/climate/patterns>
 - Team: Bradley McLamb, Corey Davis, Ryan Boyles*

- SPC Storm Reports Interactive Map:** A new database-driven mapping tool allows users to interact with the long-term tornado, hail, and high wind observations provided by the NOAA Storm Prediction Center. All tornado, hail, and wind reports from 1955 through the most recently completed year are available for the Southeastern U.S., and a dynamically generated map can be created based on user-selected criteria including: storm type and intensity, date, and state.



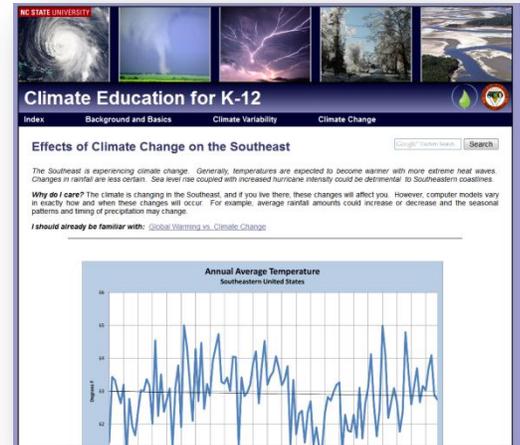
- <http://www.nc-climate.ncsu.edu/spc/map.php>
 - Team: Bradley McLamb, Corey Davis, Mark Brooks, Ashley Frazier.*

- Open Water Evaporation:** A new tool is available that provides estimated observed and long-term average open water evaporation based on a modification of the FAO56 Penman-Monteith method. This tool estimates evaporation for hundreds of location and provides visualization using tabular, time series graphs, and mapping formats.

- <http://nc-climate.ncsu.edu/openwaterevap>
 - Team: Heather Dinon, John McGuire, Mark Brooks, Ashley Frazier*

- **Climate Education Materials:** Working with SECC and Science House partners, SCO has implemented a series of modules to provide education material on climate, climate variability, and climate change in the southeast US. The web-based material allows for the context, examples, and look of the sight to be easily changed to meet specific audience needs.

- <http://www.nc-climate.ncsu.edu/edu/k12/>
- <http://www.nc-climate.ncsu.edu/edu/ag/>
- *Team: Megan Embrey, Ashley Frazier, Bryan Aldridge, Ryan Boyles*



- **Updated Holiday Climatology Page:** The holiday climatology page was updated to provide statistics for other southeastern states.
 - *Team: Ashley Frazier*
- **Model Forecast Evaluation:** A series of web tools have been implemented to provide routine and ongoing evaluation of both SCO and other numerical weather prediction models.
 - *Team: Aaron Sims, John McGuire, Heather Russett*
- **Temperature Thresholds:** A temperature threshold tool is being implemented to allow users to determine the average first/last days that high or low temperatures are above or below a user defined threshold and location. The temperature thresholds also convey the variability of the first/last days in the historical record.
 - *Team: Adrienne Wootten, Mark Brooks*

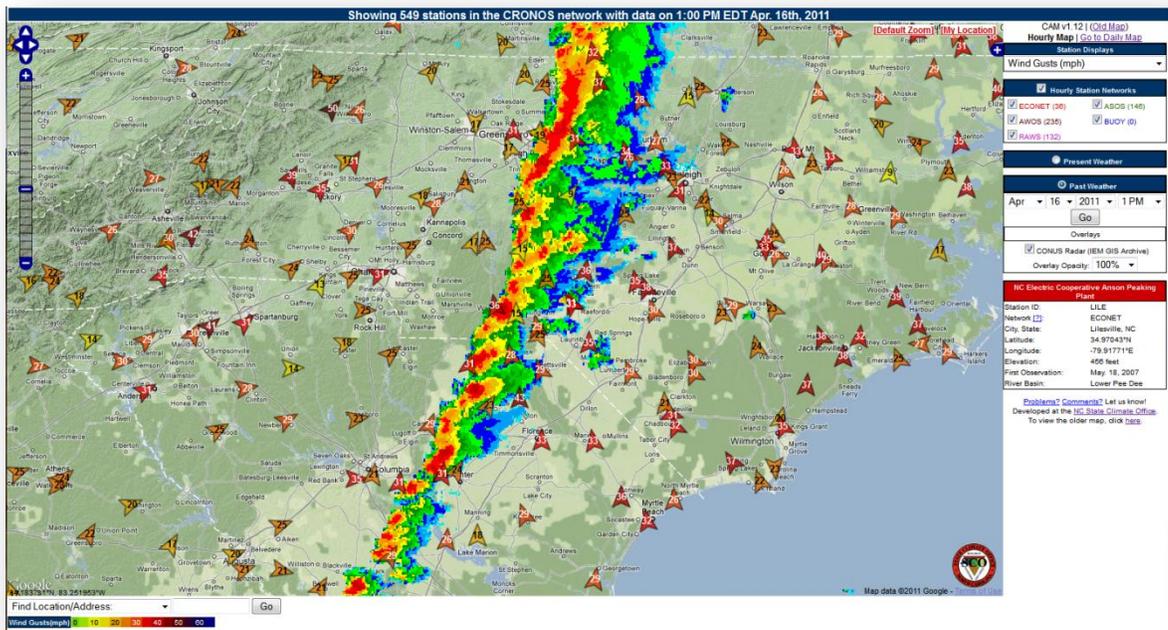
Climate Retrieval and Observations Network of the Southeast (CRONOS)

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 5,842 external queries per month to CRONOS, the SCO online climate database. This is similar to activity from the previous year.
- **Data Inputs:** Using the NOAA MADIS feed, new observations from hourly surface network are now ingested into CRONOS for use by SCO scientists, partners, and the public. MADIS provides a more robust data feed for both CRONOS and modeling applications.
- **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. Improvement over the past year include implementation of quality control flags, enabling users to request only good data or only bad data and to see the raw flags if desired. There are currently 19 total users of the API, 2 of which are paying customers in the private sector. During the period, over 605,000 external user queries were made through the API.

- **CRONOS Map:** A new tool to spatially visualize and interact with CRONOS was launched with user access to current and historical surface observations, current satellite imagery, current radar, and current watches and warnings. Internal users and partners have the ability to display any parameter, quality control flags, and observations from any time period.



- <http://www.nc-climate.ncsu.edu/map>
- *Team: Mark Brooks, John McGuire, Bryan Aldridge, Aaron Sims*

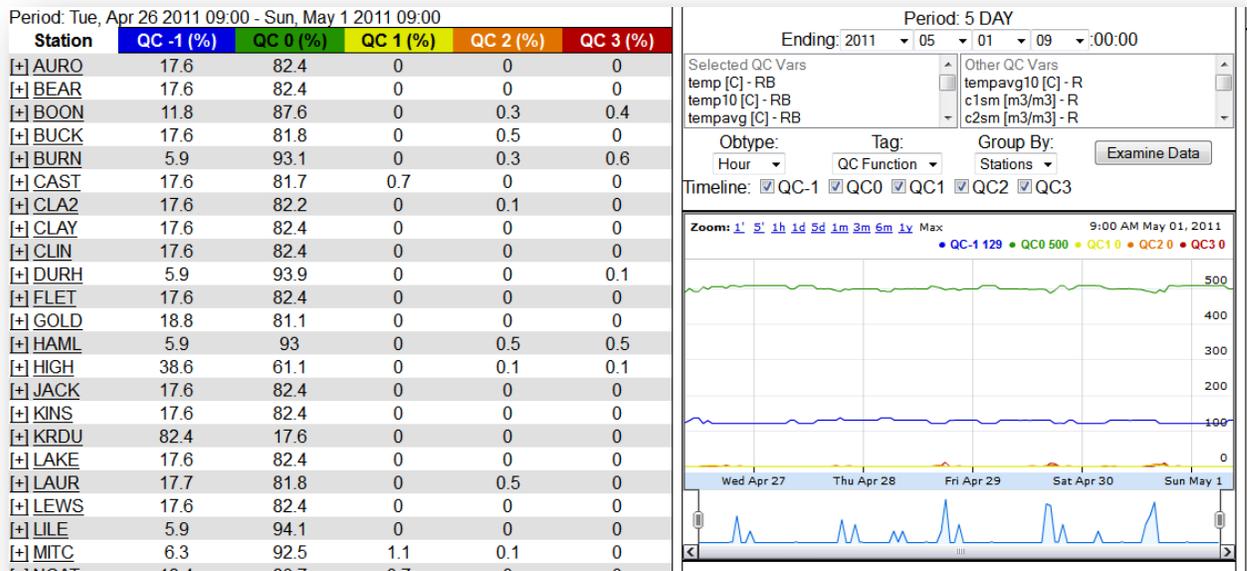
NC Environment and Climate Observing Network (ECONet)

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:** 48 field visits were made over the past year to perform routine or emergency maintenance. The station at Hamlet, NC was relocated due to construction nearby at the previous site. In addition a mobile weather station has been developed to provide improved in-field comparison and calibration.
- **Station Improvements:** Several sensors, including most radiation sensors, were replaced or upgraded over the past year. All stations now collect data every minute and 3-second wind gusts. Over the next year, additional wind sensors will be installed at 6 meter heights as part of the contract with DENR Forest Resources to meet their specific data collection needs for the National Fire Danger Rating System. In addition, a leaf wetness sensor is being evaluated at Castle Hayne to support partners in NCSU Plant Pathology, and new all-season precipitation gauge is being tested for possible deployment at high elevation stations.
- **Planned Installations:** Plans to install new stations on NCSU's Centennial Campus are on hold indefinitely. A possible site for station installation in Hyde County near Lake Mattamuskeet has been identified, and site visits and installation are planned over the next year.
- **Mount Mitchell:** With assistance from the Division of Air Quality (DAQ), one new experimental station was installed near the summit of Mt. Mitchell. This station is currently being used to determine whether wind readings at our operational site (located roughly 1 mile down the mountain) are representative given the local topography. Preliminary estimates suggest the permanent installation at the lower elevation does adequately capture the prevailing wind patterns.
- **Station Communication:** Radio-based communications using the State Highway Patrol are underway. A preliminary test of this process was successful, and expansion of this system is planned over the next several years. Eventually, we hope to use radio-frequency based communications through the State Highway Patrol for all ECONet stations. This system should both improve data relay consistency and reduce the overall costs for maintaining network communications.



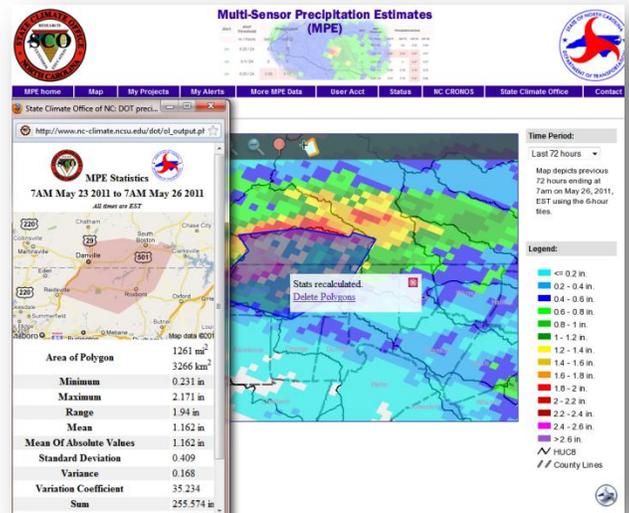
- Data Quality Control:** QA/QC efforts took major steps forward this year with a complete overhaul that includes a new basic range check procedure for all variables. Precipitation quality control is in the testing phase to utilize both the tipping-bucket data and impact sensor estimated at each ECONet site. QC of solar radiation and photosynthetically active radiation was improved to use theoretical clear sky and cloudy estimates for limits and a check to compare the values from these 2 sensors. New QA/QC visualization software was developed to enable scientists to more quickly monitor possible sensor errors through the entire ECONet.



- Station Soil Characteristics:** In collaboration with Dr. Josh Heitman and Weinan Pan (NCSU Soil Science), soil core samples were processed from most ECONET sites and relevant soil data was collected. Analysis of these soil characteristics provides the basis for 2 new calculations (Saturation Index and Plant Available Water) and development new quality control routines.
- 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 this effort, SCO will provide ECONet observations to the national mesonet program and develop enhanced metadata to ensure the quality of sensor-based observations.
- Team: Ameenulla Syed, Sean Heuser with effort by all staff and students*

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 662 user accounts for this product with 1,154 individual sites monitored. New features added include:
 - SMS text message alerts,
 - Areal precipitation statistics based on user-defined polygons
 - Improved project sites management
- This partnership with NC DOT has received 3 state and national awards
- <http://www.nc-climate.ncsu.edu/dot/>
- *Team: Ashley Frazier, John McGuire, Mark Brooks, Aaron Sims, Ryan Boyles*



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 7th year of collaborating with Dr. Shew to provide these advisories.
- *Team: John McGuire, Mark Brooks, Aaron Sims, Ryan Boyles*

Climate Information for Thrips Risk Assessment

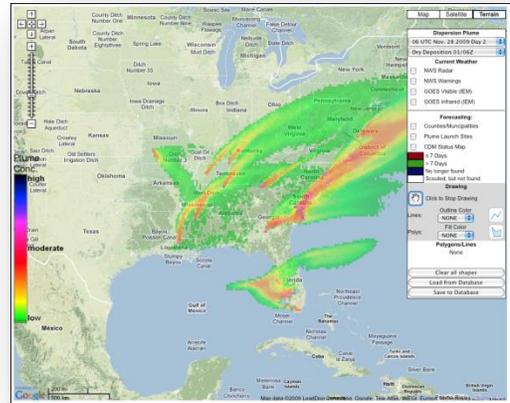
- In collaboration with Drs. George Kennedy and Hannah Burrack (NCSU Entomology), SCO has developed a web-based advisory system to evaluate the risk of thrips in tobacco. Tobacco thrips are vectors of Tomato Spotted Wilt Virus (TSWV) which causes heavy tobacco crop losses in NC. The website uses a combination of past weather data, climate data, and forecasted temperatures and precipitation to predict thrips flights dates and relative numbers of dispersing thrips for a user's location.. A beta version of the website was tested in the summer 2010 and the website will be introduced to a larger audience during summer 2011. Future plans for the website include incorporating dynamic models for predicting thrips flights based on location.
- <http://www.nc-climate.ncsu.edu/thrips/>
- *Team: Rebecca Cumbie, Mark Brooks*

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.
- <http://www.nc-climate.ncsu.edu/bluemold/map.php>
- *Team: John McGuire, Rebecca Cumbie, Mark Brooks*

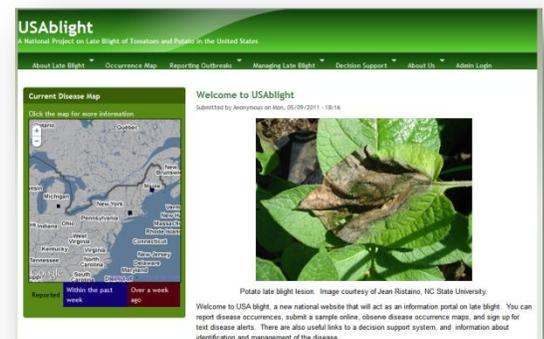
Cucurbit Downy Mildew Forecasts

- 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.
- 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.
- <http://cdm.ipmpipe.org/>
- *Team: John McGuire, Mark Brooks, Aaron Sims, Ryan Boyles*



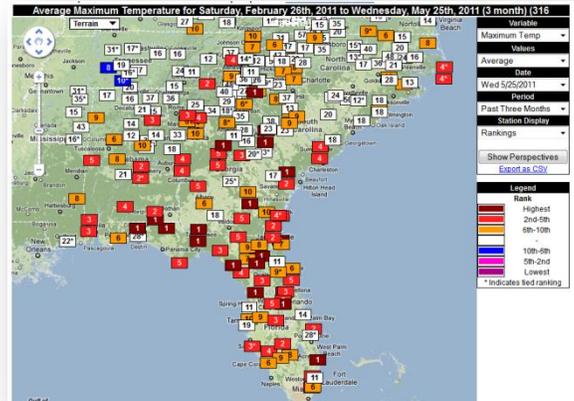
Late Blight for Potatoes and Tomatoes

- 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.
- <http://www.usablight.org/>
- *Team: John McGuire, Mark Brooks, Aaron Sims, Ryan Boyles*



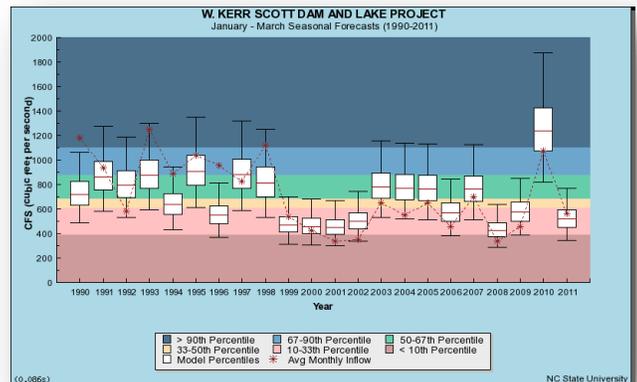
NOAA Southeast Regional Climate Center

- 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).
- 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 streak and threshold counts for temperatures, and to incorporate 3 day forecasts.
 - <http://www.sercc.com/perspectives/>
- *Team: John McGuire, Bryan Aldridge, Ashley Frazier, Mark Brooks, Aaron Sims, Ryan Boyles*



Experimental Inflow Forecasts

- In collaboration with Dr. Sankar Arumugam (NCSU Civil, Construction, and Environmental Engineering), SCO has developed a web portal to visualize experimental seasonal inflow forecasts using methods developed by Sankar Arumugam. Funded by the NC Water Resources Research Institute, this project was presented to the Urban Water Consortium has received preliminary support for further development and operational implementation.
- *Team: Andrew McNamara, Mark Brooks, Ashley Frazier, Ryan Boyles*



Fire Weather and Smoke Guidance

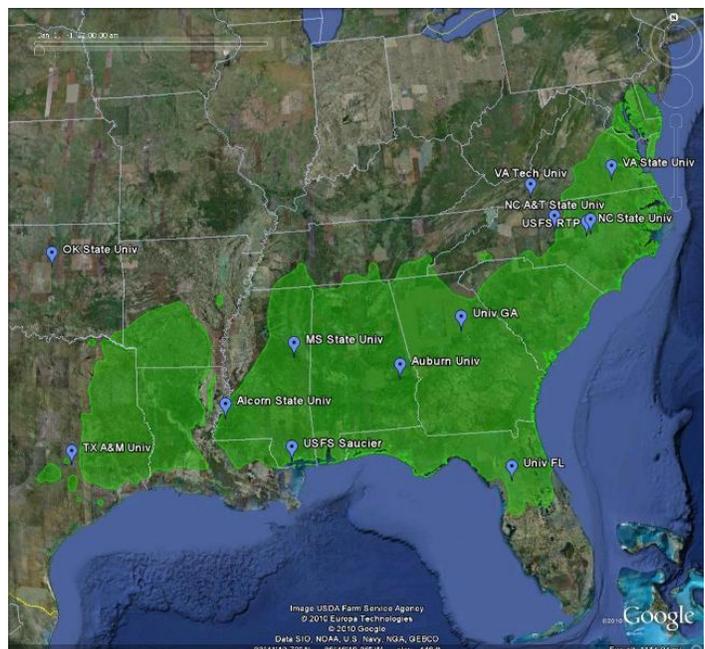
- After nearly a decade of discussions with DENR Forest Resources, SCO was awarded a contract to improve the use of weather and climate observations for fire danger monitoring and risk assessment. As part of this effort over the next year, SCO will develop tabular and map-based web tools to visualize 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.
- SCO is working with Dr. Hugh Devine, Justin Shedd, and Bob Mickler (NCSU College of Natural Resources) to develop a working implementation of the BLUESKY smoke modeling framework. BLUESKY will provide a mechanism for future research, extension, and educational activities with forestry partners.
- *Team: Corey Davis, Aaron Sims, Mark Brooks, Ashley Frazier, 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.
- *Team: Ryan Boyles*

PINEMAP: Climate Support for Southern Conifer Management

- In collaboration with 42 other investigators from across NC State University and the southern US, SCO successfully proposed 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.
- *Team: Heather Dinon, Ryan Boyles*



Applied Research

Research efforts in the past year focused on the study of North Carolina's climate and its interaction with the environment. Specific activities include model improvements, analysis of radar-based precipitation, impacts of climate patterns on NC weather and SE agriculture, and analysis of advanced downscaling methods.

Research Presentations and Publications

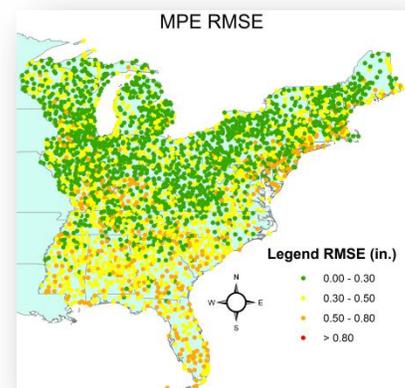
- 2 manuscripts were successfully published in peer-reviewed journals
- 2 manuscripts in review for publication in peer-reviewed journals
- 5 manuscripts are in development for submission
- 12 presentations were given at 10 scientific conferences
- 7 staff attended 13 scientific meetings and conferences

Data Assimilation for Improved Model Forecasts

- Work continues to improve SCO experimental forecasts and as a mechanism for developing a high-resolution model-based climatology dataset. In the past year, a new technique that combines both 3D-VAR and FDDA methods was tested and is being evaluated.
- A series of model sensitivity studies were performed to investigate the impacts of soil moisture, boundary conditions, and model physics options.
- *Team: John McGuire, Aaron Sims*

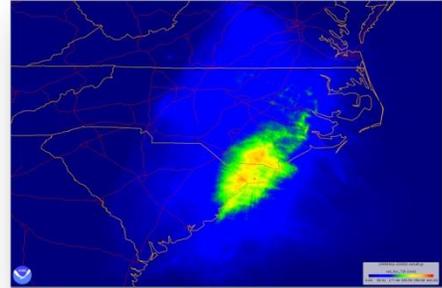
Evaluation of Multi-Sensor Precipitation Estimates (MPE)

- 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, and a manuscript in review with Journal of Hydrology. Future research in this area will involve a comparison with Q2 precipitation estimates in the Carolinas.
- *Team: Adrienne Wootten, Scott Stevens, 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 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. Over the past year, software from NSSL has been ported to NCDC and onto RENCI-based computing and raw level-II radar data over the Carolinas and Virginia are being processed with preliminary results in the summer of 2011. Collaborators are Brian Nelson (NCDC) and Ken Howard (NSSL).
- *Team: Scott Stevens, Ryan Boyles*



RENCI Lightning Network Collaboration

- SCO is developing a mapping interface to be able to more effectively compare lightning data from RENCI's lightning detection network with that from the US Precision Lightning Network. Eventually, this will help them to better calibrate their sensors to be as accurate as possible.
- *Team: Bradley McLamb, Corey Davis, Mark Brooks*

Global Climate Patterns

- SCO continues to look at the relationship between climate patterns and NC winter weather patterns, especially the NAO and NC snowfall. Analysis includes looking at the phase and phase change of NAO and its relation to snowfall, along with how the location of the negative phase anomalies impacts NC winter weather.
- *Team: Bradley McLamb, Corey Davis, Ryan Boyles*

Near-Shore Sea Surface Temperature Climatology

- SCO is developing a sea surface temperature (SST) climatology for the Virginia and Carolinas coastal region. One of the major goals of this project is to design an improved cloud filtering algorithm that will be applied to the SST data to create a more robust SST climatology. Once this climatology is created it can be used in a variety of applications relating to the region's climate. Plans for summer 2011 are to generate monthly SST composites from 2003 to the present and to validate these values against observations of skin temperature in the coastal waters and ocean provided by the National

Weather Service.

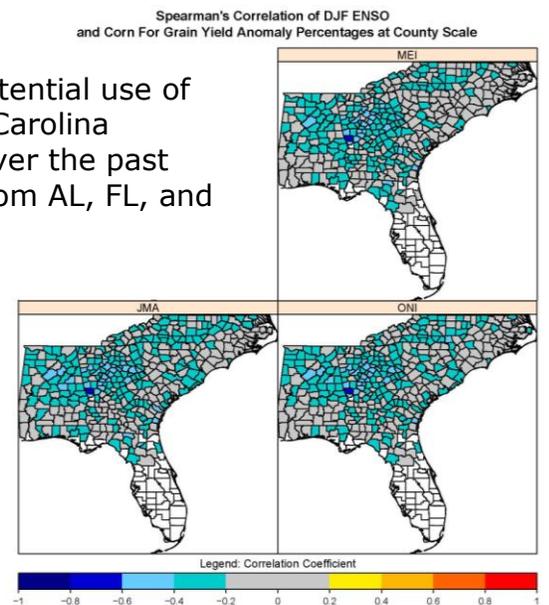
- *Team: Rebecca Cumbie, Aaron Sims, Ryan Boyles*

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.

- **Analysis of Climate Variability for Crop Management in the Southeast United States** : A comprehensive analysis of seasonal climate variability was completed over the past year, including:

- Survey work was used to quantify the knowledge, perceptions, attitudes and potential use of seasonal climate forecasts among North Carolina Extension agents. Subsequent analysis over the past year compared the NC results to those from AL, FL, and GA.
- Analysis on the relationship between seasonal ENSO phase and crop yield in peanuts, cotton, and corn across the southeastern United States.
- Evaluation of techniques to estimate solar radiation across the southeastern United States
- Analysis of the ratio of PAR to solar radiation across the Southeast US.
- Analysis of a short-term climatology of reference crop evapotranspiration based on Penman-Monteith estimation method.

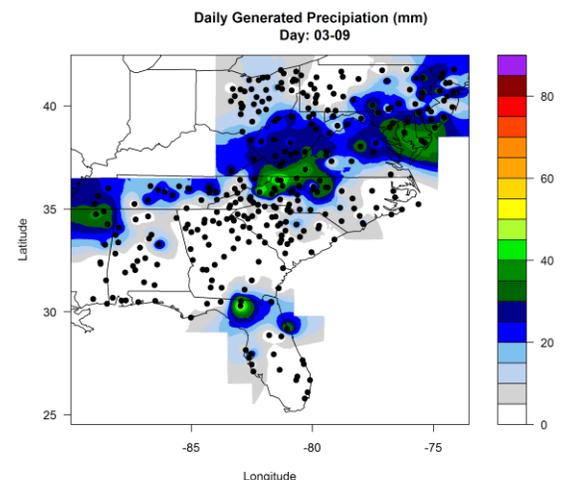


- *Team: Heather Dinon, Ryan Boyles*

- **Evaluation 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.

- Preliminary results from the evaluation indicate that the basic technique underestimates extreme precipitation events and the variability associated with tropical precipitation.
- The technique has been improved to better simulate extreme events. An



initial evaluation of the improved technique indicates that they result in a more accurate representation of extreme events, but also an overestimate of precipitation in general.

- Evaluation of downscaling with this technique is ongoing, and if the technique performs well, SCO plans implement experimental seasonal forecasts in late 2011 to early 2012.
- *Team: Adrienne Wootten, Ryan Boyles*

Educational Outreach

Educational outreach activities in the State Climate Office are designed so that climate scientists interact with K-12, community college teachers and students, and with other community organizations on different aspects of NC climate and environment. Specific activities include undergraduate and graduate student training, middle school internships, and contributions to the NC Science Olympiad and NOAA Hurricane Awareness Tour.

Undergraduate & Graduate Student Training

- SCO supported 6 undergraduate and 4 graduate students over the past year.
- Ms. Lara Pagano successfully completed Masters of Science degree in May 2010 and began a career with National Weather Service in Morehead City, NC.
- Mr. Dan McKemy, Mr. Bradley McLamb, and Ms. Heather Russett successfully completed Bachelor of Science degrees in May 2010 and continued onto Graduate School.
- Ms. Heather Dinon successfully completed Masters of Science degree in May 2011 and continues to work with the SCO as a scientist.
- Ms. Rebecca Cumbie and Ms. Megan Embrey successfully completed Bachelor of Science degrees in May 2011 and will enter graduate programs in August 2011.

Invited Presentations and Visitor Programs

- Total Direct Educational Outreach Contact Hours: 1471
- SCO staff provided 20 presentations by invitation
- SCO provided tours and programs for 12 visitor groups

Centennial Campus Magnet Middle School Internship

- SCO hosted three 7th grade student interns from Centennial Campus Magnet Middle School for the period October 2010 through March 2011. This is the 7th year of this internship program, where students spend an afternoon every week in the SCO to learn about NC climate and develop their own research projects.
- SCO received the 2011 Centennial Campus Magnet Middle School's Partnership Award for its seven years of collaboration with CCMMS
- *Team: Heather Dinon, Corey Davis, Adrienne Wootten, Ashley Frazier, Ryan Boyles*



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 has led to the implementation of 2 web-based climate educational resources targeted for Agriculture Extension Agents and K-12 educators.
- The Science House, and SCO as a partner, received the 2011 Opal Mann Green Engagement and Scholarship Award
- *Team: Megan Embrey, Heather Dinon, Ashley Frazier, Ryan Boyles*



NC Science Olympiad

- Science Olympiad is an annual science contest for middle and high school students. The theme for the state contest in 2011 was "Severe Storms", and the SCO has worked extensively to implement a test event for the NCSU State Tournament, held on April 30.
- *Team: Ashley Frazier, Heather Dinon, Corey Davis, Adrienne Wootten, John McGuire, Sean Heuser*

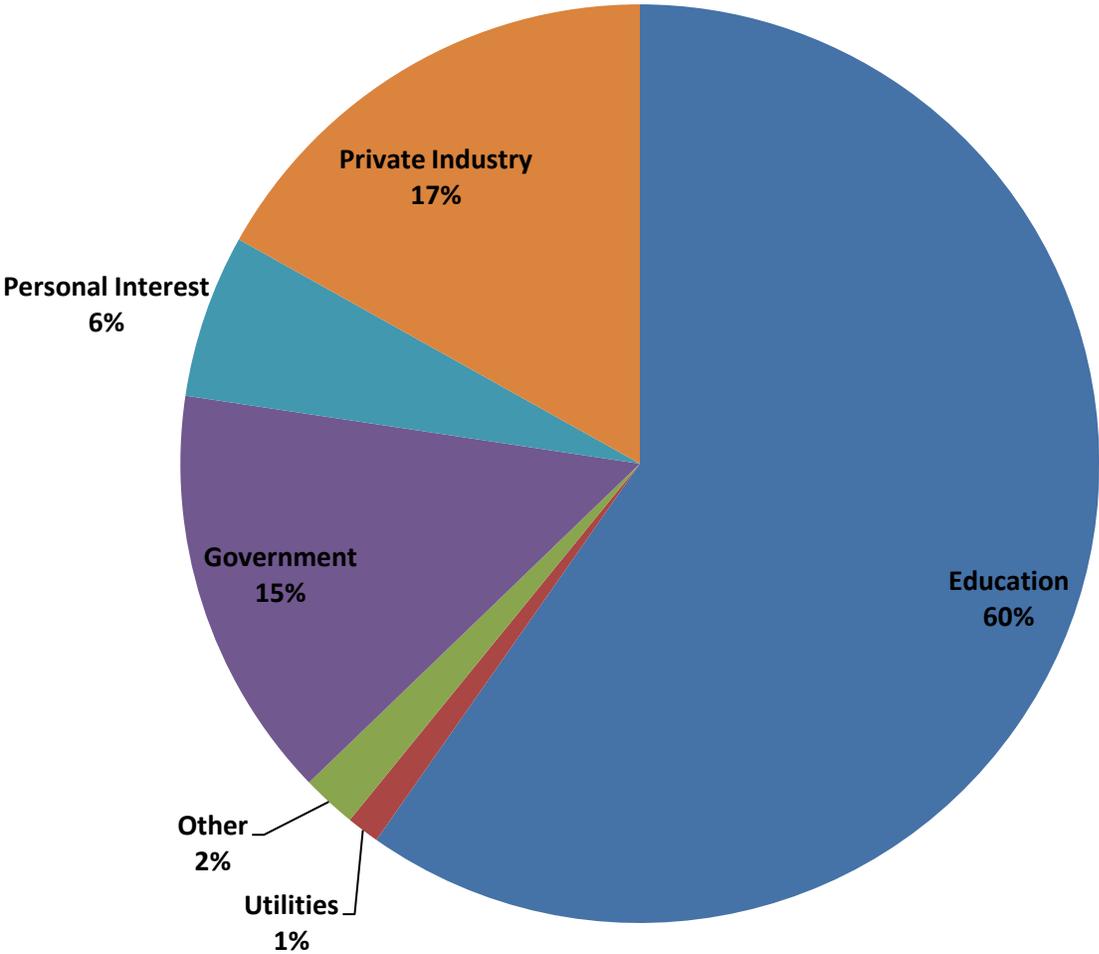
Hurricane Awareness Tour

- On May 4, 2011 the SCO participated in the Hurricane Awareness Tour at Cherry Point Marine Corps Air Station. Office staff and students helped run the SCO information tent, which was visited by the nearly 1,300 school children, VIPs, and general public who attended the event.
- *Team: Ashley Frazier, Heather Dinon, Rebecca Cumbie, Megan Embrey, Ryan Boyles*



Appendix A: Climate Services by Client Sector

Climate Information Services Effort by Client Sector
April 1, 2010 - May 20, 2011



Climate Information Services by Client Sector - Details

April 1, 2010 – May 20, 2011

Classification	Number of Requests	Hours Worked
Agriculture	9	9
Construction	35	34
Economic Development	0	0
Education: K-12	11	11
Education: NCSU/UNC	328	347
Education: Other Colleges	101	109
Government: Federal	40	43
Government: Local	19	20
Government: State	49	51
Library	0	0
Legal / Insurance	10	10
Media	8	8
Other	14	15
Personal Interest	45	45
Private Industry	71	71
Utilities	7	9
Total	746	782
Percent change *	+14%	+12%

* Compared with April 1, 2009 – May 20, 2010.

Appendix B: Simplified Budget

FY2011 Expected Budget (from May 2010)

Source	Personnel	Operating Expenses	Total	Percent
College of Physical & Mathematical Sciences	\$235,845	\$30,000	\$265,845	28%
NC Agriculture Research Service	\$134,385	\$58,000	\$192,385	20%
External Contracts & Grants	\$430,823	\$51,362	\$482,185	51%
Service Center		\$5,000	\$5,000	1%
Total	\$801,053	\$144,362	\$945,415	

FY2011 Expenditures

Source	Personnel	Operating Expenses	Total	Percent
College of Physical & Mathematical Sciences	\$210,146	\$55,588	\$265,734	28%
NC Agriculture Research Service	\$130,634	\$39,150	\$169,784	18%
External Contracts & Grants	\$474,708	\$30,307	\$505,015	53%
Service Center	\$2,884	\$17,402	\$20,286	2%
Total	\$818,372	\$142,447	\$960,819	

FY2012 Expected Budget

Source	Personnel	Operating Expenses	Total	Percent
College of Physical & Mathematical Sciences	\$235,845	\$30,000	\$254,137	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	\$842,162	\$183,227	\$1,013,681	

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. It was acknowledged by the American Association of State Climatologists as one of the first officially recognized State Climate Offices. 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.