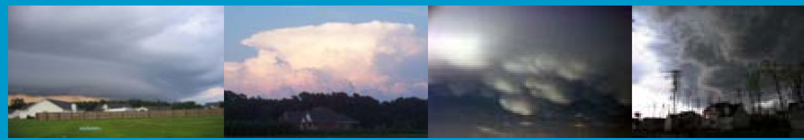


Changing Skies

Over Central North Carolina

VOLUME 9, ISSUE 1 SPRING 2012

NOAA'S NATIONAL WEATHER SERVICE RALEIGH, NC

INSIDE THIS ISSUE:

April 16th 2011; A Day to Remember

Lowes Hardware Store in Sanford, NC (Photo Courtesy of Lee County Emergency Management)

Many people across North Carolina can recall certain weather events during the past few decades, from tornadoes in the 1980's, to Hurricanes Fran and Floyd in the 1990's, and the major winter storm of January 25th, 2000. Last year, the historical tornado outbreak of April 16th, 2011 etched its own mark in the memories of countless more people over the eastern half of North Carolina. With the one-year anniversary having just recently past, here is a look back at the event.

The tornado outbreak on April 16th, 2011 was a well forecast event in which many National Weather Service Forecast Offices were able to provide the public with advance notice that severe weather was possible. For several days, forecast models indicated that strong forcing and wind shear would occur in conjunction with afternoon heating and instability, a perfect set up for a tornado outbreak. On the morning of April 16th, a cold front and line of thunderstorms moved into North Carolina from the west, slowly strengthening as it moved east. By noon, the broken line of thunderstorms had developed into a squall line that moved ahead of the cold front, and eventually erupted into numerous, discrete supercells over Central and Eastern North Carolina. Many were long-track supercells, which can be some of the most dangerous storms. In all, there were 30 confirmed tornadoes across the state, the most ever in one day in North Carolina.

The first tornado in the National Weather Service, Raleigh County Warning Area, rated an EF-1 on the Enhanced Fujita Scale, touched down in Alamance County near Graham around 2:00 PM. The same storm produced another tornado around 2:45 PM in Person County. Shortly after that, a strong supercell developed in Moore County and tracked northeast across Sanford and into Raleigh. Because the tornado, rated as high as an EF-3 at one point, moved over highly populated areas, damage was estimated to have been in the hundreds of millions of dollars. The tornado even came within 2 miles of the NWS office in Raleigh, forcing employees to temporarily suspend operations and seek shelter. Although the tornado dissipated as it moved into Franklin County, another tornado eventually developed from the same supercell when it reached Roanoke Rapids. During the next two to three hours, two more supercells would produce five tornadoes, impacting Cumberland, Harnett, Hoke, Sampson, Wilson and Wayne Counties. The strongest of these tornadoes hit Fayetteville and Smithfield, and was rated an EF-3. In all, there were nine confirmed tornadoes in Central North Carolina. The path length of the tornadoes ranged from a just few miles long up to 59 and 67 miles long for the Smithfield-Fayetteville and Sanford-Raleigh tornadoes, respectively. Total damage from all nine tornadoes was estimated at over $300 million. Over 300 people were injured, and unfortunately, the 8 fatalities were the most during the month of April, dating back to 1950.

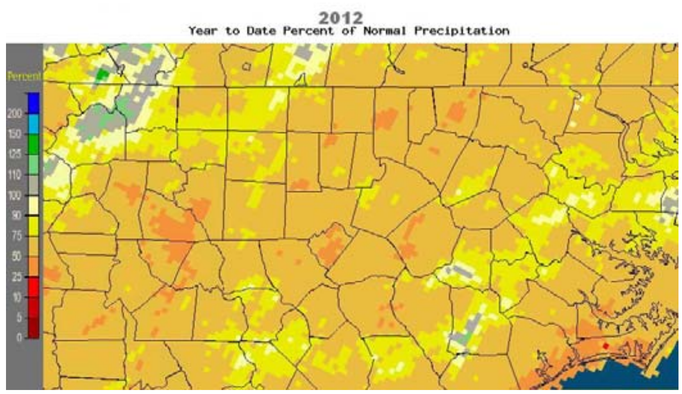
In the days following the tornadoes, meteorologists from the National Weather Service spent time on the road, surveying storm damage and talking to survivors. Many worked double shifts or came in on their day off. The damage was remarkable. The North Carolina Department of Crime Control & Public Safety reported that over 900 homes and businesses were de-

(continued on page 4)

Drought…Still With Us?

"The lack of visible impacts is masking the fact that our rainfall deficit has been gradually increasing this year."

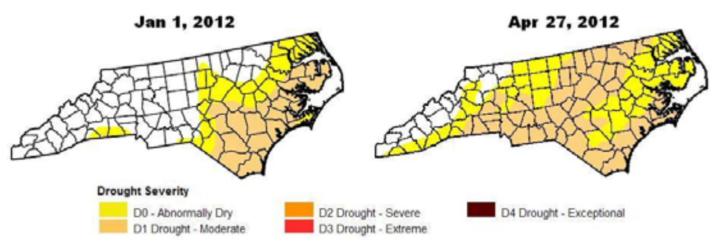
Drought hasn't been in the news much lately, as there aren't many noticeable impacts, such as an increased number of wildfires, water restrictions, or failing crops. We've had sufficient rain to allow farmers to get crops off to a good start, and the warm winter and spring promoted early greening of trees and



lawns. In addition, Falls Lake benefitted from a wetter than normal March, during which the lake rose to full pool for the first time since June 2011.
The lack of visible impacts is masking the fact that our rainfall deficit has been gradually increasing this year. We have received less than 75% of normal rainfall for the year to date over most of central NC, and some areas have received less than 50% of normal.

The US Drought Monitor (http://droughtmonitor.unl.edu/DM_state.htm?NC,SE), uses local analysis and input from the NC Drought Management Advisory Council (http://www.ncdrought.org) to produce an official depiction of drought conditions across the country on a weekly basis. The NC Drought Management Advisory Council collects input from a number of federal, state, and local government agencies. This allows for consideration of a wider range and variety of drought impacts, many of which are not readily available or visible to the public's eye. Examples of these lesser known impacts would include; in-depth statistical analysis of rainfall, small stream and groundwater levels, water quality (i.e. oxygen levels, algae blooms, etc), crop and livestock condition, and public water supply status.

Consideration of such additional factors produces a more finely detailed and accurate drought depiction, often one that looks a little more dire than what might be expected. Thus far in 2012, drought conditions across the state have expanded from 48% of the state being designated as



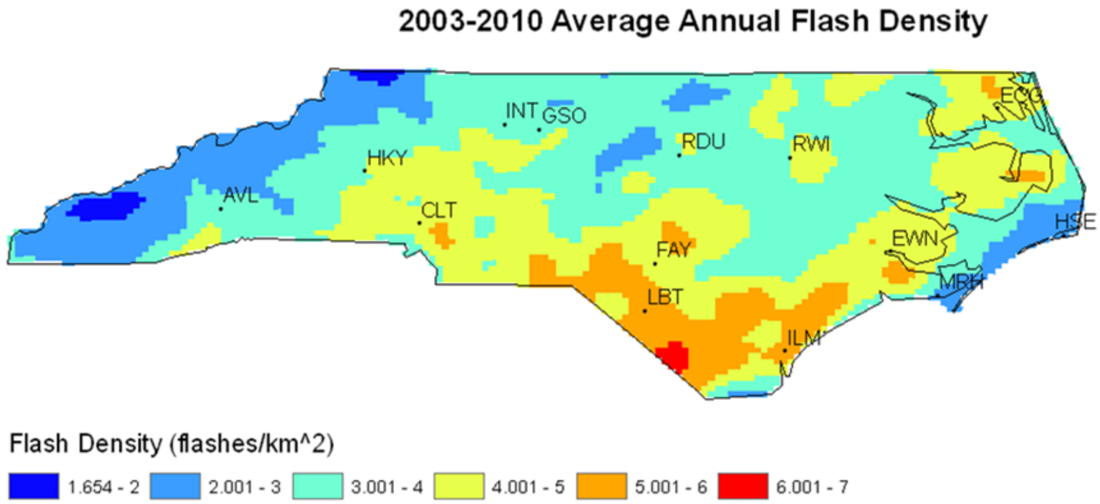
either abnormally dry (D0) or in moderate (D1) drought on January 1st, to 87% in late April. Considering only the percentage of the state in moderate drought, the numbers have increased from 27% on January 1st to 49% through the period.

Currently, the most dire drought signals across central NC are the rainfall deficit and streamflow trends. Smaller streams and unregulated rivers across the area show a very quick response to significant rain, followed by a nearly-as-quick fall back to near the original level. This is a signal that there is a deeper deficit in the stream's base flow, or groundwater levels.

Summary and Summer Forecast

Most drought impacts across central NC are not readily evident, as rainfall for the past few months, while less than normal, has been sufficient to recharge water supply reservoirs and promote an early and vigorous growing season. There is an underlying groundwater and soil moisture deficit, however, which would quickly become evident, with reduced streamflows and agricultural stress, if rainfall remains deficient into summer. North Carolina relies heavily on the generally spotty afternoon-type shower and thunderstorm activity for the bulk of its rainfall during the summer. There is no climatological signal that provides forecast skill which might give us confidence in making a precipitation forecast for the summer. Fortunately, our larger water supply reservoirs, Falls Lake and Lake Jordan, are at full pool, with enough water supply to last through the summer with no mandatory water use restrictions. They would, however, begin to fall rapidly if streamflows do remain low, especially as daytime temperatures start reaching the 90s.
–**Mike Moneypenny**

NWS Raleigh Develops a Lightning Climatology of North Carolina



Over the past several decades, cloud-to-ground (CG) lightning is one of the leading causes of weather-related fatalities in the United States, second only to flooding. In addition, North Carolina ranks sixth in the United States for the most lightning fatalities between 1995 and 2010. In order to better understand the distribution of lightning across the state, meteorologists at the NWS in Raleigh created a lightning climatology of North Carolina. The climatology explores the influences of the season, time of day, various geophysical features, and mesoscale processes on the spatial and temporal distribution of CG lightning across North Carolina. The climatology is based on eight years of CG lightning data from 2003-2010.

Based on this data set, the greatest amount of lightning generally occurs in the southeast portion of North Carolina, near Tabor City (see figure above). This local maximum coincides well with local geographically induced forcing mechanisms including the inland penetration and collision of sea breeze boundaries, the transition from clay to sandy soil just west of the Sandhills region that likely provides enhanced surface convergence, and enhanced convergence and convection associated with the Piedmont trough. Other locations near the coast, the Sandhills, along the Piedmont-Coastal Plain fall line, and the southern Piedmont contain local maxi-

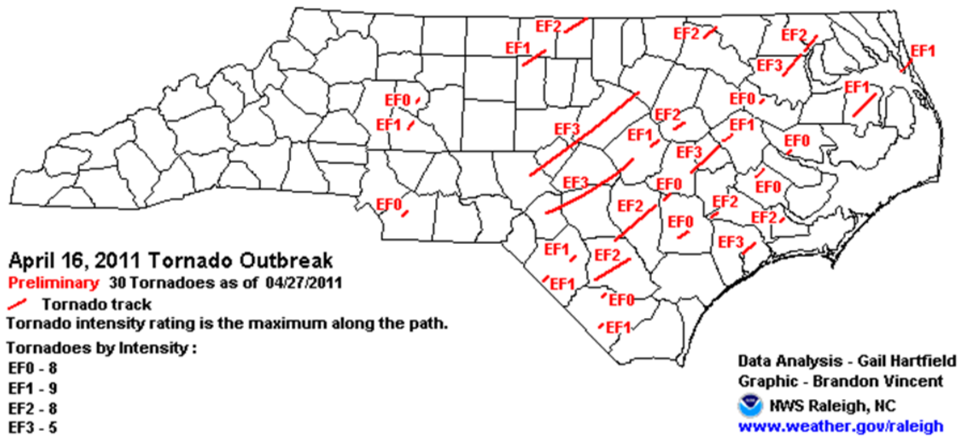
(continued on page 8)

NWS to Participate in the “got to be NC” AgFest

The NWS office here in Raleigh, NC participates in a variety of outreach activities year-round. One of the bigger events is the Got-To-Be NC Agricultural Festival. This year’s Festival will be held at the NC State Fairgrounds in Raleigh, NC May 18-20. The festival is an opportunity for us to interact with, and be available to, the people in the community we serve. We will have a booth set up with plenty of information about our office and the services we provide, as well as the weather that affects central North Carolina and how to be prepared. Please feel free to stop by our booth if you have any questions or concerns, or if you just want to say hello. We look forward to seeing you there!

-Kathleen Carroll

April 16th (continued from page 1)



stroyed and more than 6,400 were damaged across the state. The stories from people who were impacted were both fascinating and sometimes heartbreaking. However, there was an overwhelming sense that people were prepared. Good forecasts were provided days in advance, warnings were heeded, and lives were saved. There is no doubt that April 16th, 2011 will go down as one of the most memorable dates in Central North Carolina weather history, and the National Weather Service takes a lot of pride in having played a significant and positive role in public safety that day.

-Barrett Smith

The Science of Tornado Surveys

"The April 16, 2011 tornado outbreak demonstrated that North Carolina is not immune from large powerful tornadoes."

The April 16, 2011 tornado outbreak demonstrated that North Carolina is not immune from large powerful tornadoes. Immediately after this tornado outbreak was over, the NWS Raleigh staff began to form damage survey teams to go out and assess the damage caused by this massive outbreak of tornadoes. The teams conducted their damage surveys during the two days following the outbreak, and collected valuable evidence to determine the path length, width, and wind speed of each tornado. This information was ultimately used to determine the strength and Enhanced Fujita (EF) rating of each tornado, in addition to providing historical documentation of the event.

Tornado surveys serve several purposes. First, one of the primary purposes of the tornado damage survey is to simply confirm that a tornado has indeed occurred. This is because non-tornadic, straight-line, or downburst wind damage can often look very similar to damage caused by a tornado. So looking for clues of a tornado circulation is usually the first objective of a damage survey.

Once it is confirmed that damage is caused by a tornado, another purpose of the survey is to determine the strength of the tornado and assign it an Enhanced Fujita (EF) rating, or simply to determine the associated wind speed of the tornado.

A third purpose of the survey is to document the property damage and human toll for historical and research purposes. Part of the documentation process involves the survey team issuing a public information statement after they return from the damage site. This text document contains a summary of the findings from the survey. Finally, all tornado events and associated damage are documented in a national publication called "Storm Data", which is published and maintained by the National Climatic Data Center (NCDC).

To better understand how tornado surveys are conducted, we need to take a closer look at the individual parts that make up the survey process. There are approximately 8 basic steps that need to be done to properly conduct a survey, listed to the right.

It is important to point out that only properly trained NWS Raleigh staff members are permitted to conduct surveys. Fortunately, just about all the NWS Raleigh forecast and management staff meet this criteria.

8 Steps to Conduct a Tornado Survey

1.) Examine all available radar data before conducting the survery.

2.) Acquire and take appropriate survey tools and supplies.

3.) Emergency Management coordination and arranging access to the damage location.

4.) Determine the appropriate intensity of the wind damage by using the EF-Scale.

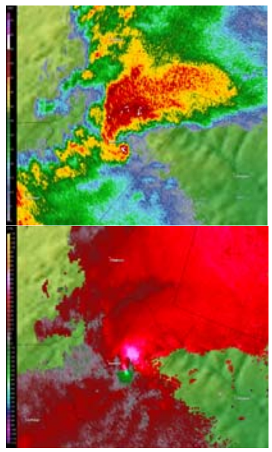
5.) Determine the character, width and length of the damage path

6.) Talk to eyewitnesses and observe and pictures or video.

7.) Respond to questions from the public and from the media.

8.) Prepare written statements and documentation.

Examining all available radar data before conducting the survey



Survey members will view the radar archive of the event and look for tornado clues such as "hook echoes" in the reflectivity data and "rotation couplets" in the velocity data. The radar images to the right show an example of a hook echo and rotational velocity couplet that were associated with the EF3 tornado that affected Sanford, NC on April 16, 2011. Viewing radar data prior to the survey provides the survey members with an idea of the approximate location to look for damage when they arrive on scene. Finally, laptops with archive radar data is usually taken with the survey team to the damage location. Viewing the radar data while looking at the actual damage helps the surveyor to construct a more complete picture of what happened and may help piece together clues that otherwise would not have come together.

Acquire and take appropriate survey tools and supplies

The NWS Raleigh maintains several storm survey kits that can be rapidly deployed in the event a post-storm survey is required. In order to conduct a successful survey, the following items are provided in these kits and used during the survey: EF-Scale, maps, witness surveys, note pads, writing utensils, compass, batteries, safety vests, sunscreen, first aid kit, camera (still and video), GPS, laptop, cell phone, hard hat, and food and water.

Emergency Management coordination and arranging access to the damage location.

Before heading out to conduct the survey, NWS personnel will notify the emergency management and central dispatch of the county or the city for the location at which the survey will be conducted. These important NWS partners will usually provide directions to the damage site, provide preliminary damage descriptions, and arrange access for NWS surveyors to visit the damage locations. NWS surveyors usually invite an individual from the agency contacted (such as a county or city emergency manager) to accompany them on the survey. When arriving on-scene or near a damage site, NWS surveyors will typically meet an emergency manager or incident commander at a command post or other designated emergency response location. With planned coordination, NWS surveyors may then get a preliminary tour of the damage sites provided by an emergency manager or emergency response official. The coordination and collaboration between the NWS and local emergency management agencies and official is crucial to the success of a storm survey.

Determine the approximate intensity of the wind damage by using the EF-Scale.

Unless a tornado circulation passes directly over a fortified wind observing system or is sampled by a doppler radar in

OPERATIONAL EF SCALE	
EF Number	3 Second Gust (mph)
0	65-85
1	86-110
2	111-135
3	136-165
4	166-200
5	Over 200

close proximity, the exact wind speeds associated with a tornado circulation usually cannot be determined in real-time, and are subsequently determined after the tornado has dissipated and the tornado damage can be surveyed. The Enhanced Fujita (EF) Scale, which ranges from EF0 with wind speeds of 65-85 mph, to EF5 with winds speeds over 200 mph, is used in this step. The EF-Scale was implemented in the U.S. on February 1, 2007 and is an update to the original F Scale that was introduced by Dr. T. Theodore Fujita in February 1971 in a research paper titled, "Proposed Characterization of Tornadoes and Hurricanes by Area and Intensity". The main goals of Dr. Fujita and the original F-Scale were to categorize each tornado by its intensity and its area, and estimate a wind speed associated with the damage caused by the tornado. Over the years, the F-Scale revealed several weaknesses, including the fact that the rating was subjective based solely on the damage caused by tornado; that is, there was a lack of damage indicators, no account of construction quality and variability, and no definitive correlation between damage and wind speed.

With the current EF-Scale (left), there is still a scale of 0 to 5 with graduated wind speeds assigned to each level, however the main improvement is the use of 28 damage indicators consisting of buildings, structures, and trees. For each damage indicator (DI), several degrees of damage (DODs) are identified. The DODs are sequenced so each one requires a higher expected wind speed than the previous one. Damage ranges from the initiation of visible damage to complete destruction of the particular DI.

In the field, the survey team will view and photograph the damage and will determine the approximate intensity of the wind damage using the EF-Scale. To effectively utilize the scale, the surveyors utilize the EF-Scale with the aid of either a printed copy of the scale, or an electronic version which runs on a laptop. Both include the entire set of damage indicators, degrees of damage, and associated wind speeds. Comparisons are made on-scene which relate the damage to both the EF-Scale damage indicators and degrees of damage. Finally an approximate wind speed and EF-Scale rating is assigned to the damage location. This is done either on-scene during the actual survey, or late in the process when reviewing photographs and detailed maps of the damage.

Determine the character, width and length of the damage path

In addition to determining the EF-Scale rating at various damage locations along the path, the tornado path length and width are determined. This is typically done by simply looking for the beginning and ending points, as well as the width edges, of the damage. The ability to get an accurate measurement of this is dependent on accessibility of the damage path. For example, if the damage is on private property and the surveyors can not get permission to enter the property, or if the terrain is simply inaccessible or unnavigable, then it may be difficult or impossible to follow an entire tornado path and determine exact length and/or width.

Assuming the surveyors have access or have been granted permission to access the damage property, then the surveyor may use a surveyor's wheel to measure path length and width, or may mark the damage beginning and end points with a GPS and plot the points on a map to determine length and width.

Talk to eyewitnesses and observe any pictures or video

Often the best way to determine and record what happened during a severe storm is to get first

-hand accounts from eyewitnesses. Eyewitnesses may be able to provide photographs or video of the event, and can often provide other critical pieces of information. Questions often asked of the public are listed on the right.

Questions asked of Public Witnesses During a Tornado Survey

What time did the storm move through?

What time did damage occur?

What did it sound like?

What did you see?

Did you receive a warning and if so how?

What type of protective action did you take?

Respond to questions from the public and from the media

Media coverage following a tornado event has become quite common, and it's not unusual for NWS survey staff to be asked to give live or recorded media interviews at a damage scene during the survey. NWS surveyors have to be prepared to respond to such requests. In addition to providing media interviews, NWS surveyors are prepared and trained to respond to questions from the public, while being sensitive to the needs and concerns of the storm victims.

National Weather Service Raleigh forecaster and storm surveyor Mike Strickler participating in a media interview during a recent tornado.

Prepare written statements and documentation

Once the survey is complete, the survey team collects their maps, photographs, and any other relevant material and return to the office. Their main goal at that point is to finalize track and damage maps and prepare and release a Public Information Statement (PNS) that summarizes the findings from the survey. In addition to the preliminary EF-Scale rating, the PNS also includes the location, date, time, maximum EF-scale rating, estimated maximum wind speed, maximum path width, path length, beginning and ending lat/lon, and number of injuries and fatalities, and a narrative description of the damage.

In addition to the PNS, survey team members will also create tornado and damage track maps and photograph collections for display on the NWS website and for use in subsequent research and case studies.

Additional information

For more information, please visit the following web sites:

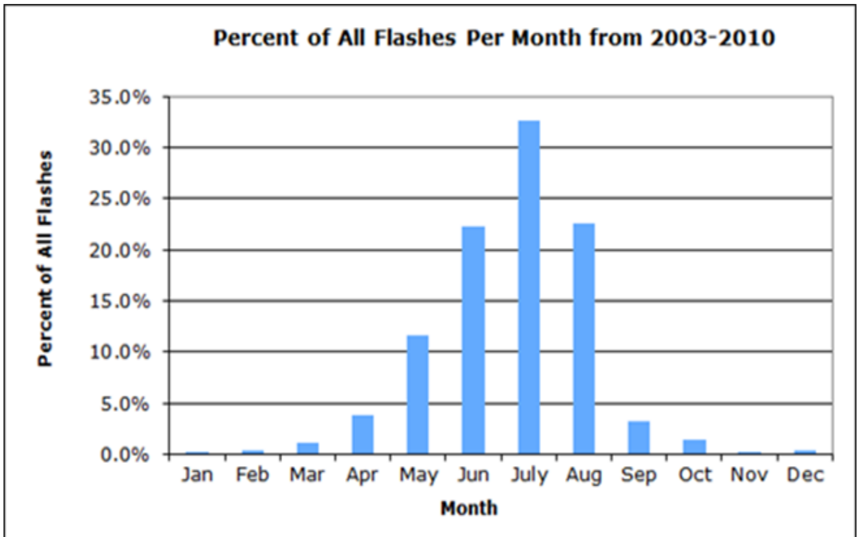
EF-Scale: http://www.spc.noaa.gov/efscale

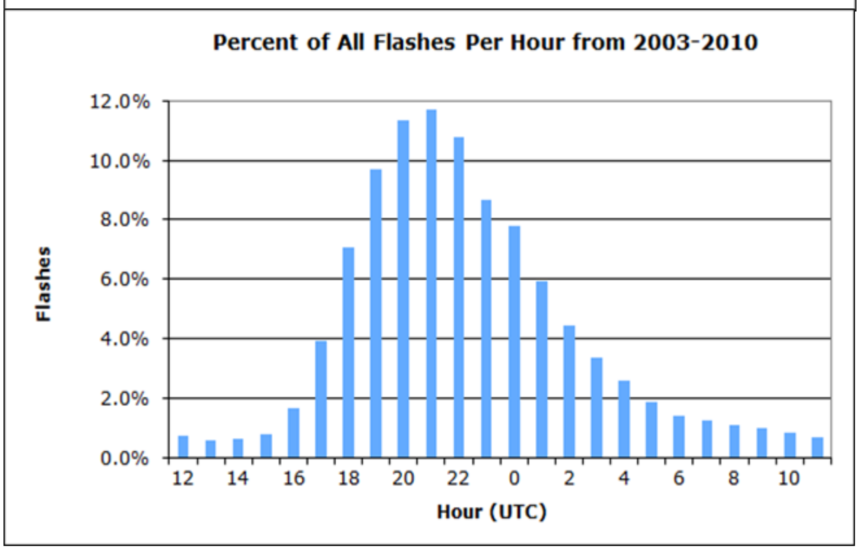
NWS Raleigh past event summaries, case studies and event maps: http://www.erh.noaa.gov/rah/events

NCDC Storm Data: http://www.ncdc.noaa.gov/oa/climate/sd/

-Nick Petro

Lightning Climatology (continued from page 3)





mums of CG lightning. Not surprisingly, the Mountains and the Outer Banks were locations with localized minimums of lightning.

Eight cities across the state were closely examined and from this group, Wilmington had the greatest number of average strikes per year while Greensboro had the fewest. Most locations experienced an average of 40 to 50 days with lightning each year. However, Asheville experienced the greatest average number of days with lightning, with approximately 57 days each year.

July was the peak month for CG lightning at all eight locations, with 36% of the annual flash count (top graph). The month with the second highest flash count varied between June and August. The summer months of June, July, and August accounted for 78% of the yearly total of lightning. Overall, the monthly data showed a steady increase in flashes from March through July and a sharp drop off after August, followed by a relatively inactive winter.

Overall, the peak hour with lightning across the state was around 5:00 PM EDT and the minimum hour was around 10:00 AM EDT (bottom graph). However, the peak hour varied geographically. The earliest peak hour, 3:00 PM EDT, was noted both in Asheville and Wilmington, likely as a result of convergence associated with the sea breeze near the coast and convergence near the mountains. Meanwhile, the cities farthest from these persistent convergence areas, Greensboro, Charlotte, and Raleigh, experienced the latest peak hour of around 6:00 PM EDT.

For more information on this project, along with numerous figures and charts, please visit http://www.erh.noaa.gov/rah/lightning/.

-Jonathan Blaes

"For more information on this project, along with numerous figures and charts, please visit http://www.erh.noaa.gov/rah/lightning/."

New Briefing Feature on Weekly Central Carolina SKYWARN™ Practice Net

SKYWARN

A new feature was recently added to the weekly Central Carolina SKYWARN™ Practice Net - The Weekly Weather Impact Briefing. Now every Tuesday evening during the Central Carolina SKYWARN™ practice net at 9:15 PM, a National Weather Service Raleigh forecaster, or the Raleigh Warning Coordination Meteorologist, Nick Petro, presents a weekly weather impact briefing for volunteers and radio amateurs monitoring the net. The briefing, which typically lasts about 5 to 10 minutes, covers topics including what the weather will be like during the remainder of the week, and what, if any, hazardous weather impacts may be possible during the outlook period. Prior to the briefing, listens can download a set of slides which help to visually convey the points made during the briefing. One of the key components of severe weather safety and preparedness is "knowing your risk" by recognizing how the weather could impact you and your family, and checking weather forecasts regularly. It is in this spirit that the National Weather Service Raleigh is happy to provide these weekly weather briefings.

You can participate in or listen to these weekly weather briefings via two methods. First, licensed amateur radio operators are invited to participate in the weekly Central Carolina SKYWARN™ net which is conducted on the WB4TQD repeater at 146.880 MHz beginning at 9:15 PM each Tuesday evening. Individuals who are not licensed amateur radio operators can listen to the weekly SKYWARN™ net and briefing via streaming audio online at http://www.radioreference.com/apps/audio/?feedId=5620. Finally, the slides that accompany the briefing are available online at: http://www.erh.noaa.gov/rah/skywarn/WeeklyBriefing/SkywarnWeeklyBriefing.pdf.

SKYWARN™ is a National Weather Service (NWS) program of trained volunteer severe weather spotters. SKYWARN™ volunteers support their local community by providing the NWS with timely and accurate severe weather reports. These reports, when integrated with modern NWS technology, are used to inform communities of the proper actions to take as severe weather threatens. The key focus of the SKYWARN™ program is to save lives and property through the use of the observations and reports of trained volunteers.

Central Carolina SKYWARN™ is the designee of the Raleigh NWS that serves the following 18 counties: Chatham, Durham, Edgecombe, Franklin, Granville, Halifax, Harnett, Johnston, Lee, Nash, Orange, Person, Sampson, Vance, Wake, Warren, Wayne, and Wilson. Central Carolina SKYWARN™ operates under the specific direction of the National Weather Service. For more information about Central Carolina SKYWARN™, please visit the following website: http://ccskywarn.net. Here you'll find information about the weekly practice net, Central Carolina SKYWARN™ amateur radio frequencies, SKYWARN™ spotter training class dates and locations, severe weather preparedness tips, and other useful SKYWARN™ links and information.

The National Weather Service Raleigh would like to thank all of their SKYWARN™ volunteers and amateur radio friends for their weather reports, help and commitment to the National Weather Service's mission of protection of life and property.

- Nick Petro

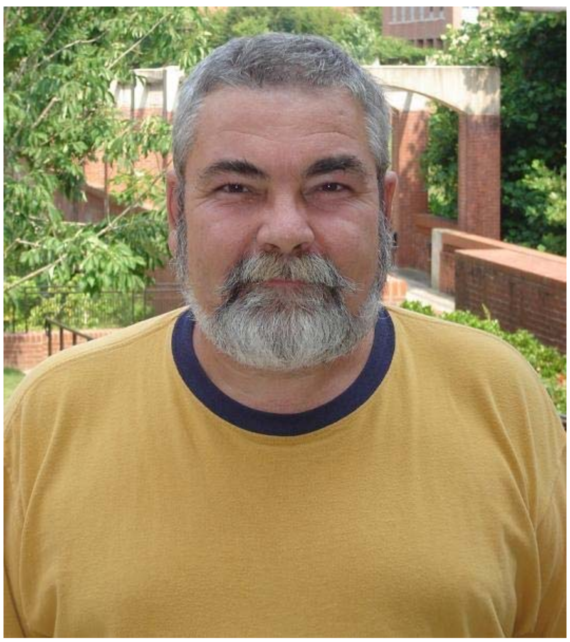
"The briefing, which typically lasts about 5 to 10 minutes, covers topics including what the weather will be like during the remainder of the week, and what, if any, hazardous weather impacts may be possible during the outlook period."

NOAA's National Weather Service
Raleigh, NC

1005 Capability Drive
Suite 300
Centennial Campus
Raleigh, NC 27606

Phone: 919-515-8209
Fax: 919-515-8213
Forecast Line: 919-515-8225

Electronics Technician Karl Lenzen Retires



NWS Raleigh electronics technician Karl Lenzen retires May 3 after nearly 37 years of dedicated service to his country, the National Weather Service (NWS) and, for the last 26 ½ years, the Raleigh Forecast Office.

Karl served in the 1970s in the Navy, stationed in Scotland, San Diego, and Key West. In 1979, he was hired in the NWS at the National Hurricane Center as a meteorological aid, becoming a meteorological technician in 1980. Karl's work there focused on communications and mapping, and he was instrumental in the programming of the center's Automation of Field Operations and Services (AFOS), one of the first major computing systems in NWS offices. In 1985, Karl transferred to the Raleigh office as a meteorological technician, and in 1987, he was selected as a Raleigh electronics technician, where he served until his retirement.

Over the last 25 years, Karl has served the Raleigh electronics program well. He is known and respected for his work with the Automated Surface Observing System (ASOS), taking the lead on many test projects and providing critical feedback. Karl has also been essential to the success of electronics support in many other areas at Raleigh, helping support the NWS Doppler radar, NOAA Weather Radio transmitters, and upper-air and numerous communications systems, while taking on the duties as the NWS Raleigh Safety Focal Point. Karl established and promoted a sound environmental, safety, and health program at the office.

Always willing to help, Karl received numerous awards for service. For example, he was honored as a member of Eastern Region Teams of the Month four times from February, 2008 to March, 2011 for successfully reconfiguring or refurbishing NWS offices in the mid-Atlantic and the Carolinas. He was also a 2005 regional award winner for innovation and persistence in helping to solve a telephone line problem with the Raleigh WSR-88D.

We wish Karl all the best as he begins the next phase of his life, and we'll miss him at the Raleigh office.

-Darin Figurskey