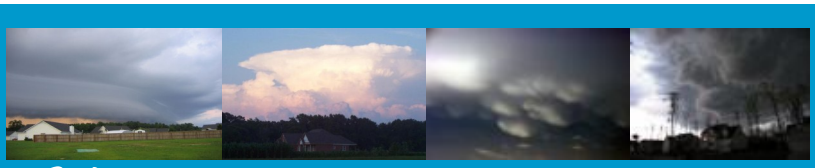


Changing Skies Over Central North Carolina

VOLUME 10, ISSUE 2 SUMMER 2013
NOAA'S NATIONAL WEATHER SERVICE RALEIGH, NC

INSIDE THIS ISSUE:

Summer Starts Out Wet in Central NC

Franklin Street in Chapel Hill after flash flooding . (Photo courtesy of Jason Baker)

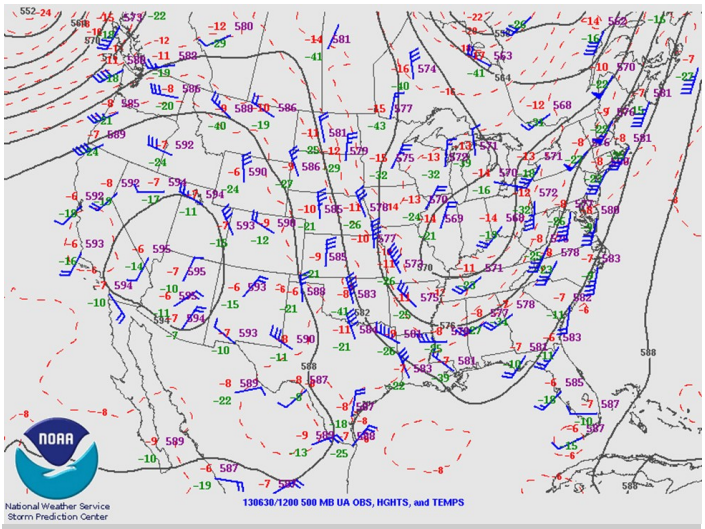
People across central North Carolina started this summer wondering where the summer had gone!

Rainfall for 2013 had been running within a couple of inches of normal through June and drought had slowly been easing its grip on the Tar Heel State. At the end of the first week of June, early-season tropical storm Andrea laid a swath of 3-5+ inches of rain across central NC, wiping away lingering abnormally dry conditions for the first time since April 2010.

In addition to Andrea, a stagnant pattern with little day-to-day change held over the area for most of the month of June. This pattern consisted of very moist air surging into the region from Florida and the Gulf of Mexico, along with a nearly stationary trough to our west, from the Great Lakes down the Mississippi River valley. The figure below shows the late-June weather pattern, with the low pressure trough to our west and the deep flow from the south pumping copious amounts of moisture northward over the East Coast, and the amount of rainfall observed in central North Carolina for June, 2013. With the exception of the Triad area, the rest of the area received rainfall ranging from 8 inches to over 15 inches for the month. In fact June, 2013 was the 3rd wettest June ever in the Raleigh-Durham area (records kept since 1887), with 10.08 inches of rain reported at the RDU airport. June, 2013 was also the 9th wettest month ever in the Fayetteville area (8.58 inches; records have been kept since 1998), and 2nd wettest month ever in the Rocky Mount/Wilson area (9.65 inches; records kept since 2000). Chapel Hill was especially hard-hit: during the last week of June, nearly 10

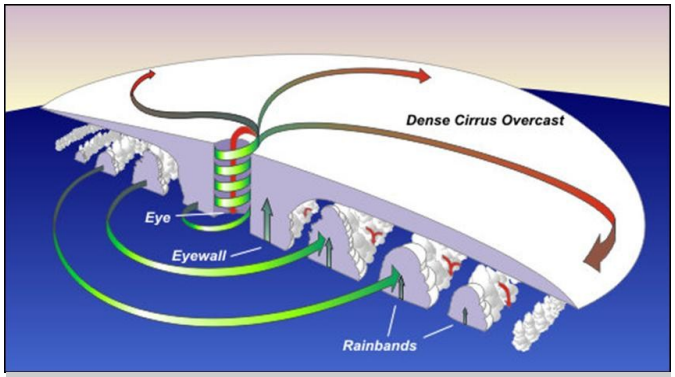
(continued on page 6)

inches of rain fell in Chapel



June Weather Pattern Over the Continental United States

Tropical Cyclone Rain Band Tornadoes



Hurricane Structure (NC State Climate Office)

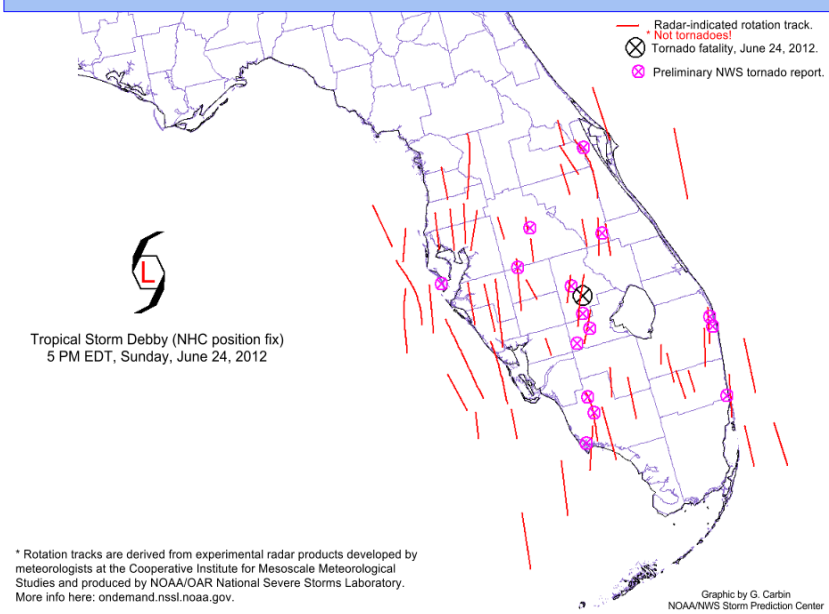
Rain bands are long, arching bands of clouds and thunderstorms that spiral out from the eye wall of a hurricane. Heavy bursts of rain and wind are usually associated with rain bands. These structures form the outer most fringes of the tropical cyclone structure, and the winds contained within the bands decrease outward from the eye wall. With landfalling hurricanes, tornadoes are a common threat associated with rain bands coming onshore.

Tornadoes associated with tropical systems typically form in the right front quadrant of the storm, relative to the direction of forward motion. If you were looking at the storm like it was a clock, this would be the area from about noon to three o'clock in the direction the storm is moving. While not normally as intense as tornadoes produced by non-tropical severe thunderstorms, these tornadoes often move very fast, at speeds over 50 mph. Another common area of tornadoes in a hurricane is in the far outer rain bands, which can be hundreds of miles away from the center of the storm.

Tropical cyclone (TC) tornados aren't just a coastal phenomenon. In fact, TC tornadoes can occur well inland from the coast, including across central North Carolina and even westward. In fact, there has already been a TC-related tornado in central North Carolina in 2013, when shortly after 6 PM on June 10 a rain band associated with the remnants of Tropical Storm Andrea spawned a brief and weak tornado near Louisburg, Franklin County. A couple other notable TC tornado events that have happened across central North Carolina include:

Tropical Storm Fay, August 25-28, 2008: Three tornadoes were confirmed and dozens of spotter reports of funnel clouds or rotating wall clouds were received.

24h radar-indicated circulations* and tornadoes associated with Tropical Storm Debby
Sunday, June 24, 2012



"While not normally as intense as tornadoes produced by non-tropical severe thunderstorms, these tornadoes often move very fast, at speeds over 50 mph."

Hurricane Jeanne, September 27-28, 2004: Rain bands associated with Jeanne produced several tornadoes over the Sandhills and Piedmont of North Carolina. Tornado touch downs were reported in Moore, Richmond and Wake Counties

Hurricane Ivan, September 17, 2004: Tornadoes, varying in intensity from F0 to F2, touched down producing damage to homes, businesses, and trees in Guilford, Rockingham, Moore, and Chatham Counties.

Just last year in South Florida Tropical Storm Debby caused 15 tornadoes with 1 fatality (see figure on Page 2).

While TC tornadoes tend to be weaker and shorter-lived than non-TC tornadoes, the same safety rules apply. Whenever a tornado warning is issued, or if you see threatening weather approaching, move to a predesignated shelter, such as a basement. If an underground shelter is not available, move to an interior room or hallway on the lowest floor and get under a sturdy piece of furniture. Stay away from windows. If in a car, do not try to outrun the tornado. Rather, find a suitable business or building to seek shelter. Mobile homes, even if tied down, offer little protection from tornadoes and should be abandoned for more sturdy nearby structures. Remember to have multiple ways to receive warnings, such as a NOAA Weather Radio, a battery powered TV or radio, or a cell phone app that delivers warnings to your phone. For more information about severe weather safety and planning, please visit www.ready.gov/severeweather.

Credits: State Climate Office of North Carolina, and Florida Climate Center

-Nick Petro

NWS Raleigh Forecasters to Share Research at NWA Conference

The NWS Raleigh plans on sharing results from four research projects at the 2013 National Weather Association (NWA) annual meeting in Charleston S.C. in October. The projects reflect a diverse set of topics that pose a significant forecast challenge and/or a potentially significant weather impact to central N.C. NWS Raleigh has an established culture of successful applied research that has benefitted operational forecasters.

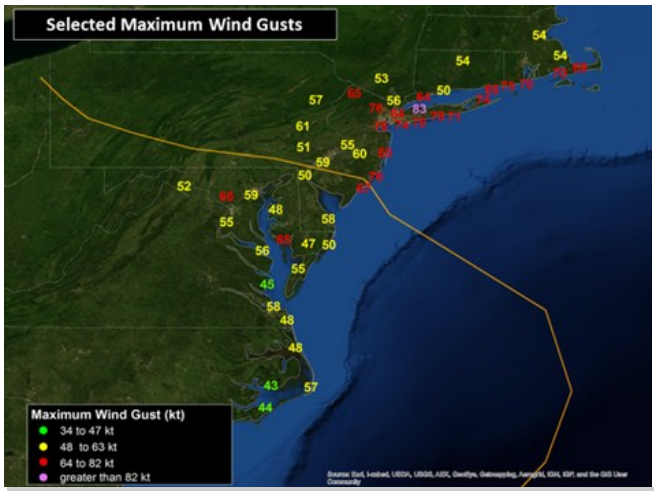
Sharing results at conferences is an important part of the research process for several reasons. Most importantly, it provides an opportunity for other scientists to review and provide feedback including shortcomings, ways to improve the project, and other interpretations of the results. These comments typically result in a much improved final project that is more complete after being probed by scientists of varying backgrounds who have experience in the topic being presented.

Titles of projects that we hope will be shared at the 2013 NWA conference:

- A Climatology of Cold Air Damming and Tropical Cyclones in the Southeast U.S.
- Developing a Dataset of Wind Gust Factors to Improve Forecasts of Wind Gusts in Tropical Cyclones
- Investigation of Extreme Lightning Days in North Carolina
- Orographically Induced Cirrus Clouds East of the Southern Appalachian Mountains

-Jonathan Blaes

A look Back at the 2012 Tropical Season and a Few Changes for 2013



Selected Wind Gusts From Hurricane Sandy

"2012 hurricane forecast verification shows some impressive statistics. The forecast track error exceeded records in many parts of the forecast period. Intensity forecasts also exceeded records from 72 to 120 hours out."

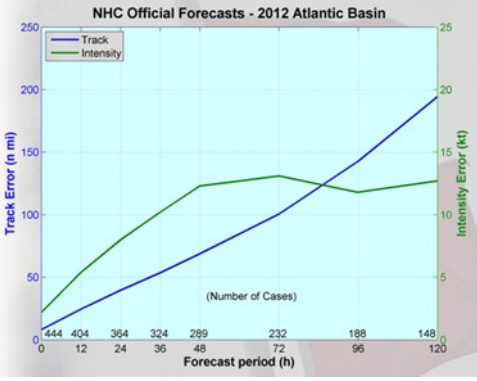
Looking back at the 2012 Atlantic hurricane season, nineteen tropical storms formed, with ten becoming hurricanes and two becoming major hurricanes. The number of tropical cyclones that formed, as well as the number of hurricanes, were both well above average. In a typical Atlantic hurricane season, there are 12 storms, with six becoming hurricanes and three of those developing into major hurricanes.

Sandy was the deadliest and most destructive storm of the season, and the latest statistics show it is now the second costliest tropical cyclone in U.S. history. Impacts extended from the Caribbean north through the Bahamas and the eastern United States, including coastal North Carolina, and then west to the Great Lakes.

Isaac also had significant impacts particularly from flooding along the Gulf Coast in and around Louisiana. Other tropical systems that hit or affected land areas included Beryl, Debby, Ernesto, Gordon, Helene, Leslie, Nadine, and Rafael. The 2012 season started early with two storms in May, and Nadine was one of the longest-lived Atlantic storms of record. In fact, Nadine completed three loops over the eastern subtropical Atlantic, attaining hurricane strength on two occasions a record thirteen days apart. Nadine's 22.25 (non-consecutive) days as a tropical cyclone makes it the fourth longest-lived Atlantic basin tropical cyclone on record. The 20.75 days Nadine spent as a tropical storm and hurricane makes it the third-longest-lived named storm on record. Only the Unnamed 1899 hurricane and Ginger (1971) lasted longer.

2012 hurricane forecast verification shows some impressive statistics. The forecast track error exceeded records in many parts of the forecast period. Intensity forecasts also exceeded records from 72 to 120 hours out.

Track and Intensity Verification



VT (h)	NT	TRACK (n mi)	INT (kt)
000	444	8.2	2.2
012	404	24.6	5.4
024	364	39.7	8.0
036	324	53.6	10.2
048	289	68.8	12.3
072	232	100.6	13.1
096	188	142.8	11.8
120	148	194.4	12.7

Values in red exceed all-time records.

Another active season is predicted for the 2013 Atlantic hurricane season, and some changes by the National Hurricane Center (NHC) for this season include the definitions of tropical storm and hurricane watches and warnings being broadened, and issuance criteria of advisories being changed, to allow NHC the option to use tropical-type watches and warnings for post-tropical cyclones* that pose a significant threat to life and property. This is a result of events that took place with Sandy as it lost tropical characteristics while moving toward the New Jersey shore, and the new criteria has already been used this season with Andrea.

Later in the season, the NHC plans to extend the Tropical Weather Outlook (TWO) out to five days. Currently, the TWO goes out to 48 hours, but after the NHC completes some development and testing, it is hoped that by August the NHC will note the potential for systems to become tropical within the next five days. You can find the latest TWO on line at:

http://www.nhc.noaa.gov/text/refreshMIAT-WOAT+shtml/171742_MIATWOAT.shtml

Atlantic Cone Radii – 2013 vs. 2012

Improving track accuracy = smaller cone size

Forecast Period (h)	2012 Circle Radius (n mi) ('07 – '11 errors)	2013 Circle Radius (n mi) ('08 – '12 errors)	Percent Change
12	36	33	-8%
24	56	52	-7%
36	75	72	-4%
48	95	92	-3%
72	141	128	-9%
96	180	177	-2%
120	236	229	-3%

Storm size has not changed = more impacts outside cone

In addition, the NHC forecast cone size has again been reduced for the 2013 season. Compared to the cone used in the 2012 hurricane season, the cone size has been reduced at all valid forecast hours from 2% to nearly 10%. This is a function of improved track accuracy over the years. What we need to keep in mind, though, is that the size of the storm has no relationship to the size of the cone. The cone represents the probable track of the tropical cyclone center. The cone does not tell anything about impacts. As cones shrink, the larger the storm, the more the storm's impacts will be felt outside of the cone.

Be sure to review information from the NHC, your local NWS forecast office, and community leaders if another tropical cyclone approaches this season. Away from the coast, primary threats include heavy rains resulting in flash flooding and swollen rivers and streams, brief but still dangerous tornadoes, and strong, gusty winds. Remember that heavy rains can saturate the ground and make it easier for trees to fall in winds that might not be considered very strong. This was the case in some areas of central North Carolina with Andrea. As part of your safety considerations for this and future hurricane seasons, you will want to keep in mind reconsidering outdoor activities in gusty winds during and immediately following widespread, very heavy rainfall.

Much of the information in this article is courtesy of the National Hurricane Center's Hurricane Specialist Unit.

-Darin Figurskey (source:NHC)

***Post-tropical cyclone definition: This generic term describes a cyclone that no longer possesses sufficient tropical characteristics to be considered a tropical cyclone. Post-tropical cyclones can continue carrying heavy rains and high winds. Note that former tropical cyclones that have become fully extratropical, as well as remnant lows, are two specific classes of post-tropical cyclones.**

NOAA Predicts Active 2013 Hurricane Season

In its 2013 Atlantic hurricane season outlook, NOAA's Climate Prediction Center is forecasting an active or extremely active season this year.

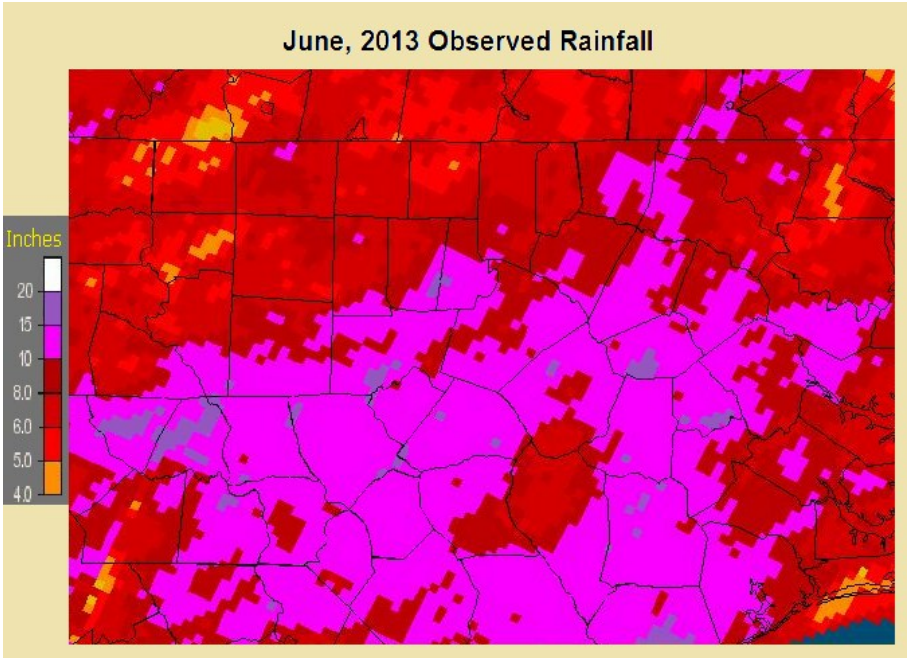
For the six-month hurricane season, which begins June 1, NOAA's Atlantic Hurricane Season Outlook says there is a 70 percent likelihood of 13 to 20 named storms (winds of 39 mph or higher), of which 7 to 11 could become hurricanes (winds of 74 mph or higher), including 3 to 6 major hurricanes (Category 3, 4 or 5; winds of 111 mph or higher).

These ranges are well above the seasonal average of 12 named storms, 6 hurricanes and 3 major hurricanes.

"With the devastation of Sandy fresh in our minds, and another active season predicted, everyone at NOAA is committed to providing life-saving forecasts in the face of these storms and ensuring that Americans are prepared and ready ahead of time." said Kathryn Sullivan, Ph.D., NOAA acting administrator. "As we saw first-hand with Sandy, it's important to remember that tropical storm and hurricane impacts are not limited to the coastline. Strong winds, torrential rain, flooding, and tornadoes often threaten inland areas far from where the storm first makes landfall."

Three climate factors that strongly control Atlantic hurricane activity are expected to come together to produce an active or extremely active 2013 hurricane season. These are: (continued on page 7)

Summer Starts out Wet in Central NC (from page 1)



Hill, most of it within just a couple of days. This was the 2nd wettest June ever in Chapel Hill, where records have been kept since 1891. Several neighborhoods were badly flooded, forcing residents to evacuate their homes, and parts of Franklin Street near the UNC campus were underwater, as shown in the picture on page 1. Areas of Stanly county and Anson county, just east of Charlotte, were also hard hit by flooding with many roads closed or even washed away. Plenty of people across the area are hoping for drier weather through August, as the peak of the hurricane season approaches and we start to focus on the growing potential for tropical systems, which often bring heavy rain to North Carolina.

-Gail Hartfield and Mike Moneypenny

"This was the 2nd wettest June ever in Chapel Hill where records have been kept since 1891."

Hurricane Sandy as Seen From Space

A continuation of the atmospheric climate pattern, which includes a strong west African monsoon, that is responsible for the ongoing era of high activity for Atlantic hurricanes that began in 1995;
Warmer-than-average water temperatures in the tropical Atlantic Ocean and Caribbean Sea; and
El Niño is not expected to develop and suppress hurricane formation.
"This year, oceanic and atmospheric conditions in the Atlantic basin are expected to produce more and stronger hurricanes," said Gerry Bell, Ph.D., lead seasonal hurricane forecaster with NOAA's Climate Prediction Center. "These conditions include weaker wind shear, warmer Atlantic waters and conducive winds patterns coming from Africa."

NOAA's seasonal hurricane outlook is not a hurricane landfall forecast; it does not predict how many storms will hit land or where a storm will strike. Forecasts for individual storms and their impacts will be provided throughout the season by NOAA's National Hurricane Center.
New for this hurricane season are improvements to forecast models, data gathering, and the National Hurricane Center communication procedure for post-tropical cyclones. In July, NOAA plans to bring online a new supercomputer that will run an upgraded Hurricane Weather Research and Forecasting (HWRF) model that provides significantly enhanced depiction of storm structure and improved storm intensity forecast guidance.
Also this year, Doppler radar data will be transmitted in real time from NOAA's Hurricane Hunter aircraft. This will help forecasters better analyze rapidly evolving storm conditions, and these data could further improve the HWRF model forecasts by 10 to 15 percent.
The National Weather Service has also made changes to allow for hurricane warnings to remain in effect, or to be newly issued, for storms like Sandy that have become post-tropical. This flexibility allows forecasters to provide a continuous flow of forecast and warning information for evolving or continuing threats.
"The start of hurricane season is a reminder that our families, businesses and communities need to be ready for the next big storm," said Joe Nimmich, FEMA associate administrator for Response and Recovery. "Preparedness today can make a big difference down the line, so update your family emergency plan and make sure your emergency kit is stocked. Learn more about how you can prepare for hurricane season at www.ready.gov/hurricanes."
-NOAA

2013 Hurricane Season Forecast Highlights

- ***70% Chance of 13-20 Named Storms***
- ***7-11 Hurricanes***
- ***3-6 Major Hurricanes***

Seasonal Averages

12 Named Storms, 6 Hurricanes, 3 Major Hurricanes

NOAA's National Weather Service
Raleigh, NC

1005 Capability Drive
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Centennial Campus
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Forecast Line: 919-515-8225

NWS Raleigh Taking Facebook and Twitter by Storm

Do you use Facebook or Twitter? These social media sites continue to grow by leaps and bounds, and NWS Raleigh forecasters are in on the action. Since we started our Facebook page in the summer of 2011, NWS Raleigh has posted a wide variety of information including storm surveys; briefings on upcoming significant weather such as winter storms, severe weather, and tropical systems; details on our new dual-polarization radar technology, interesting weather happenings around the country, even a photo contest in which the winners were featured on the top of our page. We're very pleased to have amassed over 3,200 dedicated fans so far! And we don't just "push" information – we want to hear from you about our products and services, as well as gather your severe weather reports, and our Facebook page is a great means to do just that. If you are on Facebook and not yet a fan of NWS Raleigh, please check us out at https://www.facebook.com/US.NationalWeatherService.Raleigh.gov

As of the summer of 2012, we've also entered the world of Twitter! In just the last several months, we have tweeted up-to-the-minute information on severe weather and flooding, tornado track information live from the survey itself, and breaking news on developing tropical systems. We've recently sought the assistance of a North Carolina State University graduate student, Keith Sherburn, who has helped out with social media at our office during severe weather outbreaks, working with forecasters to provide moment-by-moment updates on storm locations, paths, eyewitness reports, and impacts. With Keith's help, forecasters can provide crucial details quickly to the public and our other partners such as the DOT, county officials, and local media. We really appreciate our more than 1,250 Twitter followers, and hope that number continues to grow! Our Twitter handle is @NWSRaleigh.

While there is sometimes some overlapping information between our Facebook and Twitter posts, we try to reserve Twitter for quick-hitting, rapid-update information, while on Facebook we might post a more detailed briefing or case study. So if you are on either Facebook, Twitter, or both, please consider bringing NWS Raleigh into your social media world!

-Gail Hartfield