Carolina SkyWatcher

National Weather Service, Newport/Morehead City, NC

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Fall 2014 Edition

Sixtieth Anniversary of Hurricane Hazel

October 15, 2014 will mark the 60th Anniversary of Hurricane Hazel. The Category 4 storm is the strongest hurricane to ever make landfall in North Carolina and the only Category 4 ever to strike the state. Hazel made landfall near Calabash, North Carolina, close to the North Carolina/ South Carolina state border. The hurricane brought a storm surge of over 18 feet to a large area of the North Carolina coastline, producing severe coastal damage. Intensifying the damage was the fact that the hurricane coincided with the highest lunar tide of the year. Brunswick County suffered the heaviest damage, where most coastal dwellings were either completely destroyed or severely damaged. As a result of the high storm surge, the low-lying sandy barrier islands were completely flooded. An official report from the Weather Bureau in Raleigh stated that as a result of Hazel, "all traces of civilization on the immediate waterfront between the state line and Cape Fear were practically annihilated." The December 1954 NOAA report on the hurricanes of the year states that "every pier in a distance of 170 miles of coastline was demolished".

The coastal area near the landfall was battered by winds estimated to have been as high 150 mph. Winds of 98 mph were measured in Wilmington while winds were estimated at 125 mph at Wrightsville Beach and 140 mph at Oak Island. A storm surge of over 12 feet inundated a large area of coastline reaching as high as 18 feet at Calabash, where the storm surge coincided with the time of the lunar high tide and Hazel nearly wiped out Garden City, SC.

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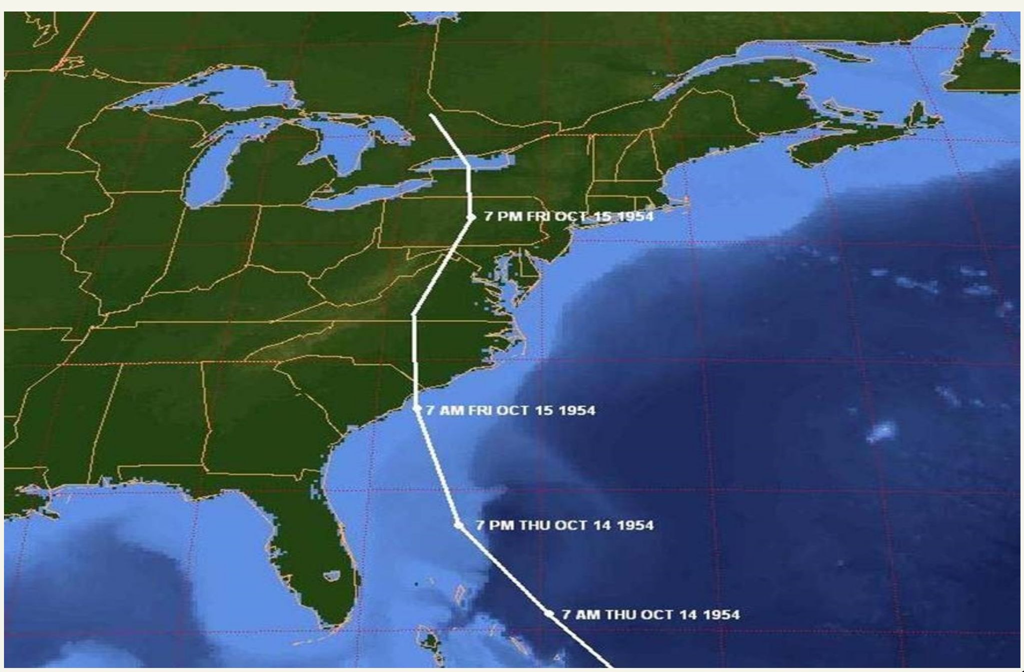


Track of Hurricane Hazel, October 14-15, 1954

Hurricane Hazel Anniversary (Continued)

As Hazel moved rapidly inland, its winds only slowly diminished with a gust to 110 mph reported at Fayetteville and 90 mph at the Raleigh-Durham Airport. Wind gusts near 100 mph were reported from numerous locations in Virginia, Maryland, Pennsylvania, Delaware, New Jersey, and New York as Hazel raced northward. Myrtle Beach, SC reported a peak gust of 106 mph. Closer to home, Hazel brought recorded gusts of 120 mph to Faison and Kinston. Hazel brought devastating storm surge to Onslow and Carteret Counties, washing out highways and bridges in Snead's Ferry, Morehead City, Atlantic Beach, and Beaufort.

In Carteret County, Hazel caused tremendous property damage. Tony Seamon and his father, owners of the Sanitary Restaurant in Morehead City, drove to the restaurant during the storm and cut holes in the floor to drain the rising water out of the building. Their effort saved the restaurant, and it was able to serve as a feeding center after the storm.

The damage from Hazel was not limited to the coast. With Hazel having a forward speed of as much as 55 mph at times, strong winds continued well inland causing heavy damage to forests, and to property as a result of falling trees. In North Carolina, the most rain was received in the interior of the state: Robbins received 11.3 inches of rain, and Carthage received 9.7 inches.

Nineteen people were killed in North Carolina, with several hundred more injured; 15,000 homes were destroyed and another 39,000 were damaged. Damages in the Carolinas amounted to $163 million. Beach property incurred $61 million of damage alone. Elsewhere in the eastern United damages were estimated at $145 million for a total of $308 million in losses from the hurricane.

Damage to the Beaufort-Morehead City Causeway

Severe Surge Flooding in Morehead City

Photos Courtesy Associated Press

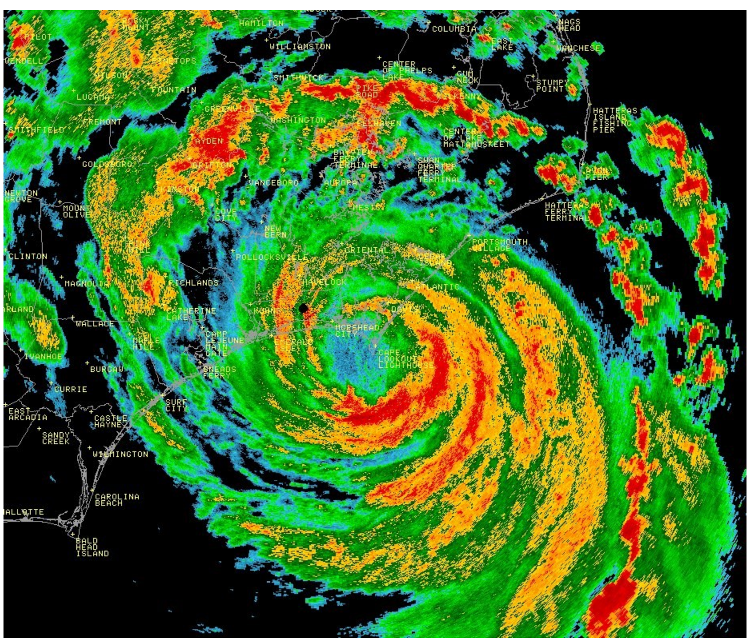
Hurricane Arthur Affects the Area

By Chris Collins and David Glenn, Meteorologists

Hurricane Arthur is the earliest hurricane to hit North Carolina in a season since records began in 1851. The previous record was July 11, 1901. It is also the first hurricane to make landfall on the U.S. mainland since Isaac on Aug. 28-29, 2012 and the first Category 2 hurricane in the U.S. since Ike in 2008.

Arthur became a tropical depression on July 1. The system continued to strengthen, and was declared a tropical storm later that afternoon. Drifting northward, the storm reached hurricane status early on July 3 and recurved toward the north-northeast in response to a cold front to the north. The storm intensified further, and by late on the evening of July 3, the system attained its peak winds of 100 mph as a Category 2 hurricane on the Saffir–Simpson Hurricane Wind Scale. Arthur made landfall at 11:15 pm July 3, over Shackleford Banks, between Cape Lookout and Beaufort, and intensified slightly further, with a minimum pressure of 972 mB or 28.73 inches/mercury at the Ocracoke Weatherflow site. The storm then accelerated northward, weakening as it passed by Cape Cod and Nantucket before transitioning into an extratropical cyclone on July 5.

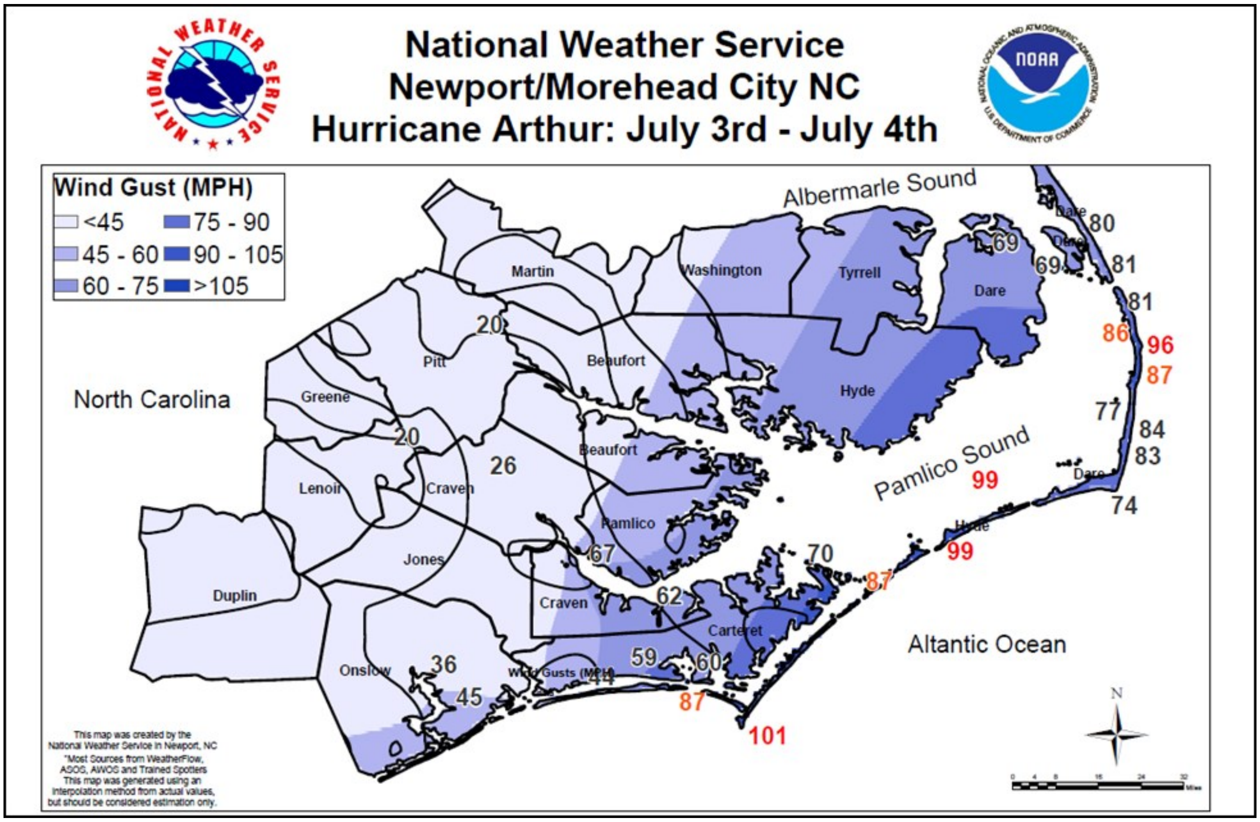
Widespread power outages were reported throughout coastal eastern North Carolina. Surge flooding up to 4 to 5 feet above normal was observed over the central and northern Outer Banks with portions of NC Highway 12 and U.S. Highway 64 closed in Dare County. The peak wind gust during the storm was 101 mph at Cape Lookout.



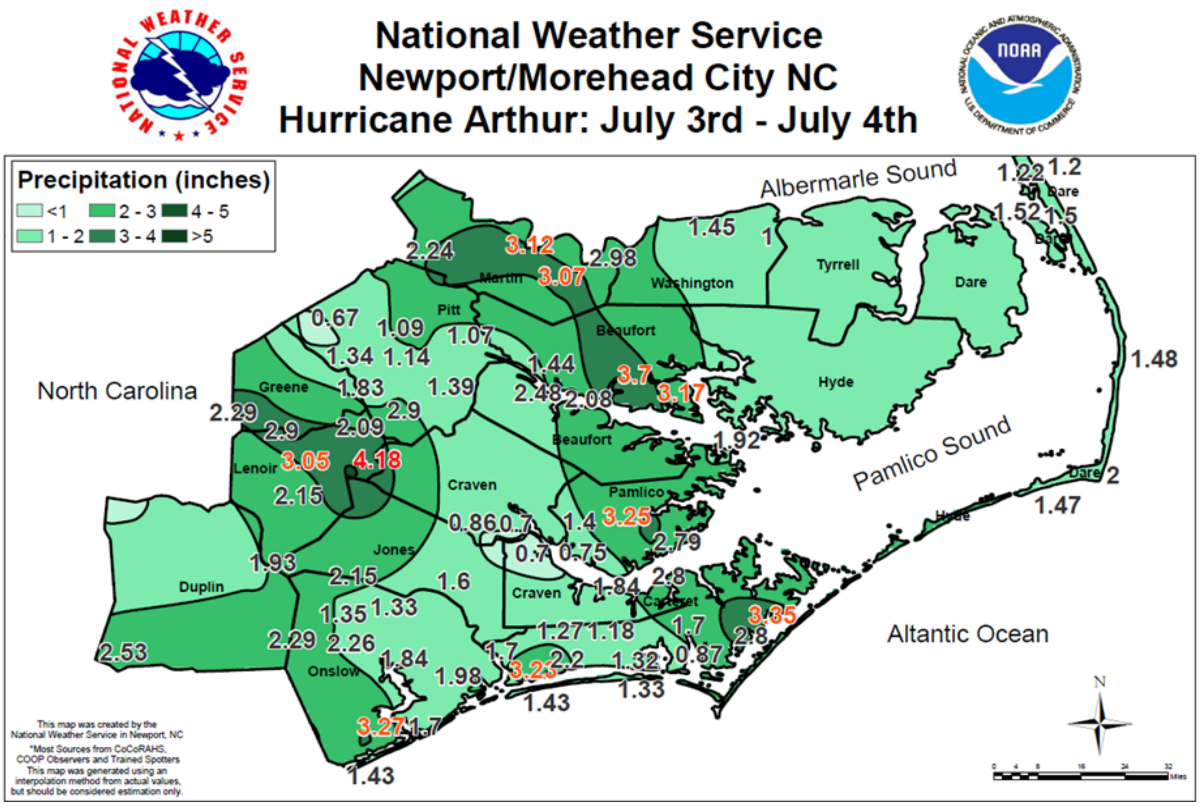
Eye of Hurricane Arthur making landfall at Shackleford Banks

Overwash on Highway 12 at Mirlo Beach
Courtesy NC Department of Transportation

Hurricane Arthur Affects the Area (Continued)

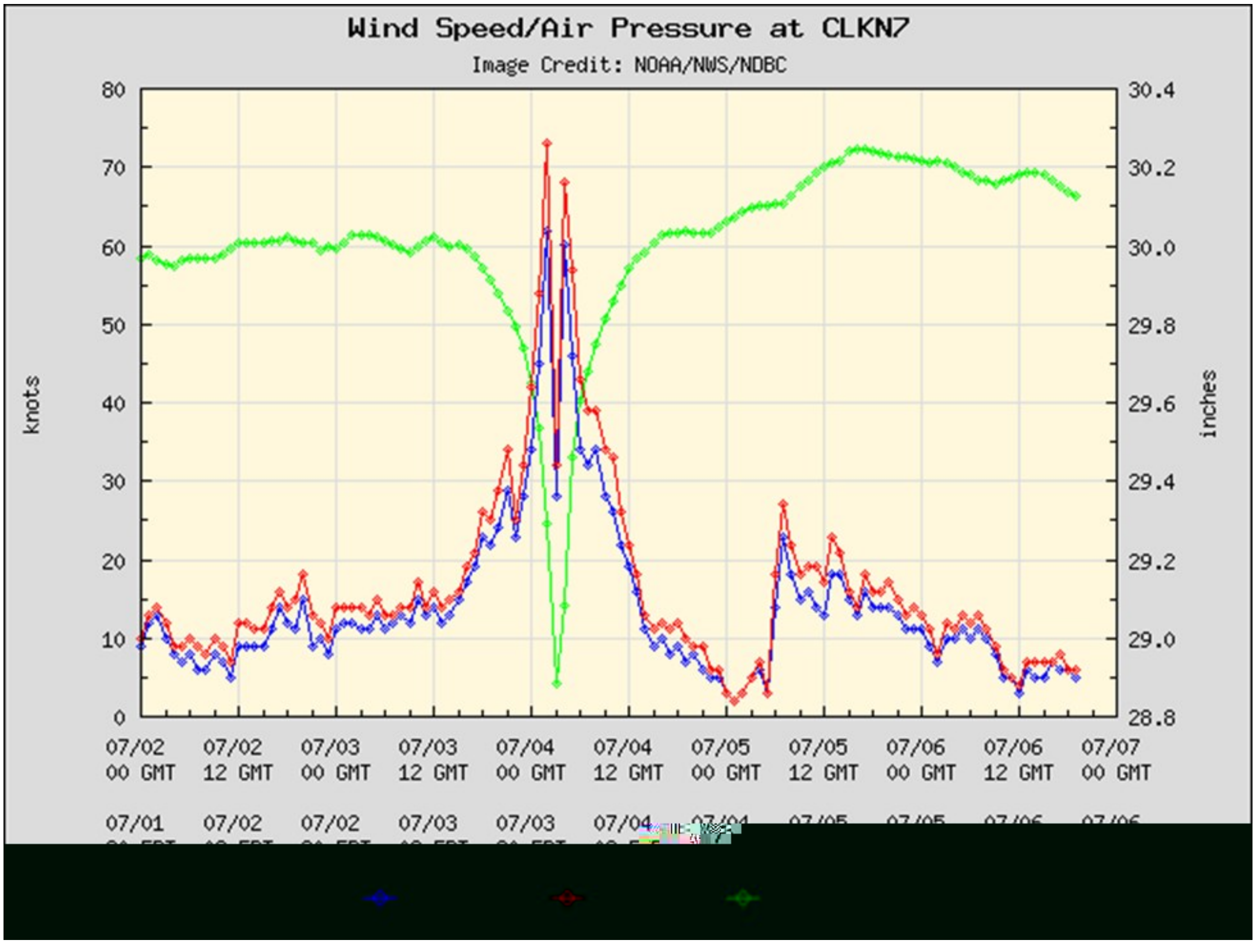


Peak Winds observed during Hurricane Arthur, July 3-4, 2014



Observed Rainfall from Hurricane Arthur, July 3-4, 2014

Hurricane Arthur Affects the Area (Continued)

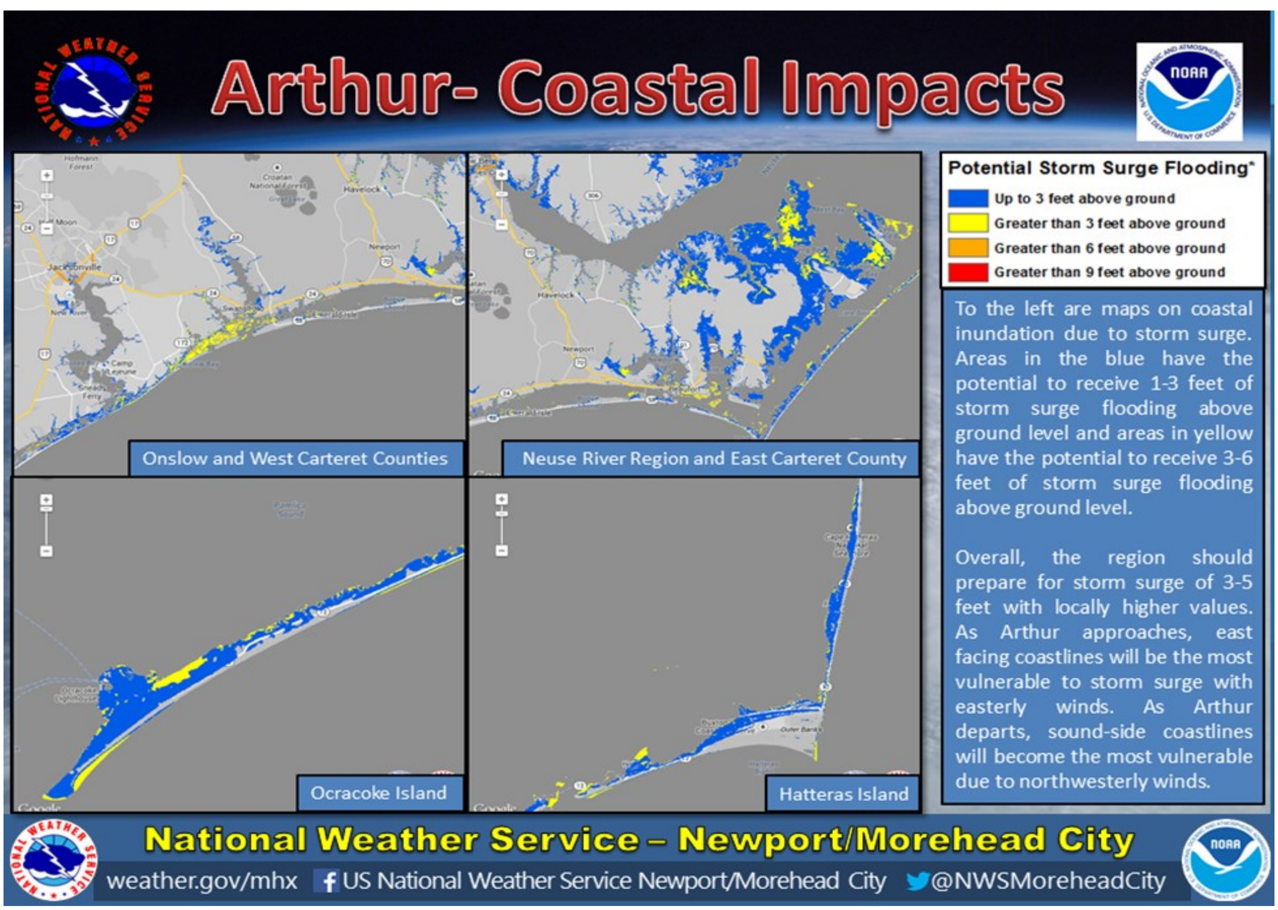


Wind speed (blue), wind gusts (red), and atmospheric pressure (green) recorded at Cape Lookout C-Man station. Peak winds were 77 mph with a peak gust of 101 mph (strongest observed winds for Hurricane Arthur).

Temporary bridge and erosion of part of HWY 12 near Pea Island (right). Photo courtesy of NC DOT.

Hurricane Arthur Affects the Area (Continued)

Silver Ford Mustang was blown into ditch as an EF1 tornado associated with Hurricane Arthur touched down near Rose Hill in Duplin County. Photo courtesy of WCTI viewer photos.

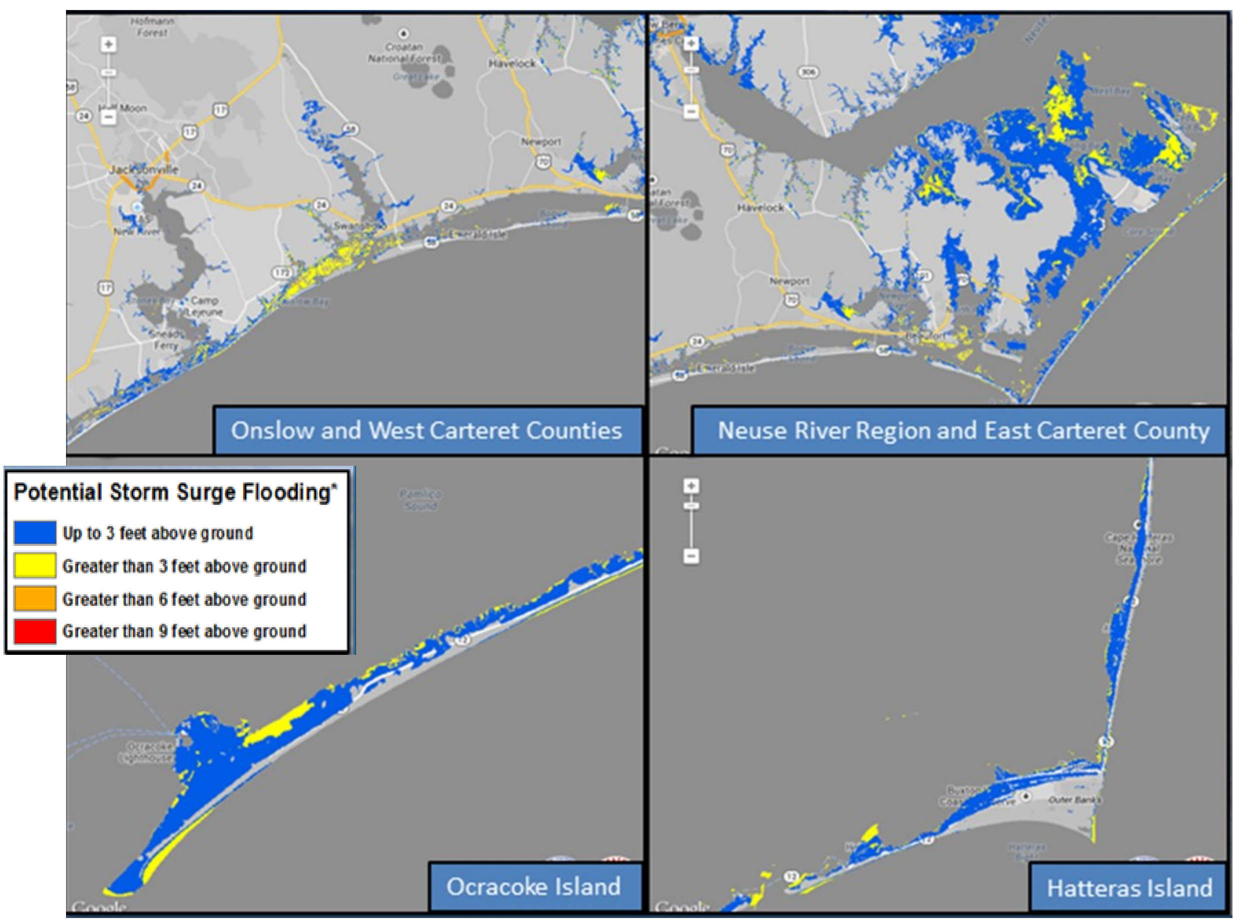


Hurricane Arthur Marked the First Use of Experimental Potential Storm Surge Inundation Graphic

By David Glenn, Meteorologist

The Potential Storm Surge Flooding Map is an experimental product from the National Hurricane Center (NHC). It provides valuable information on the potential storm surge flooding for areas along the Gulf and East Coast of the United States at risk from storm surge during a tropical cyclone event. It was the result of years of developmental work on the technical side, as well as extensive social science research to help craft the most effective graphic possible to convey this complex and deadly threat. This research included focus groups held here in Eastern North Carolina.

Below is a capture from the Hurricane Arthur forecast. The map shows geographically where inundation levels have a 1-in-10 chance (10 %) of being exceeded, and can therefore be thought of as representing a reasonable worst-case scenario. The depiction shows how high ***above ground*** the water could reach in any given location. This is what a person in that area should ***be prepared*** to experience. Those living in areas that could be inundated should evaluate their risks and consider evacuating, especially if one is called by local officials.



Testing Flash Flood Procedures at the Weather Prediction Center

By Lara Pagano, Meteorologist

In July, I had the pleasure of representing the Newport/Morehead City NWS office at an experiment conducted by the Weather Prediction Center (WPC) in College Park, MD. I worked closely with forecasters at WPC and from various other Weather Forecasting Offices (WFO) and Weather Centers on a Flash Flood project; the goal being to make advancements in Flash Flood prediction. The second annual Flash Flood Intense Rainfall Experiment (FFaIR) was a project aimed at evaluating the utility of high resolution models and ensembles for short-term flash flood forecasting. During the week, a full suite of high resolution weather models were analyzed in an effort to isolate possible location for flash flood events for any given day. These models were later evaluated on their performance against the actual observed rainfall and flash flood reports.

The project also explored future changes to current WPC operational Outlooks and Mesoscale Precipitation Discussions. As an example, probabilistic forecasting has become more popular in terms of expressing confidence in a certain forecast or event. Hence, in the future, WPC will likely approach the synoptic and mesoscale outlooks using probabilities.

During my time at WPC, I was able to work with both researchers and modelers during the flash flood interrogation process. Collaborative efforts were mimicked between the national centers and the smaller WFOs as witnessed during real time events. This led to some insight on the communication process and how it may be improved in the future. Much was gained on current and future modeling endeavors. New models were used during this experiment that led forecasters at the WFO level to become eager for their upcoming release.

The experiment outcome is based on input from the various participants. The WPC will then tailor the future products based on the feedback from the experiment itself. While it would seem evident that the WPC gained quite a bit from this project, I can assure you, the forecasters came away with far more knowledge about the process than was previously known.

Flash Flood Intense Rainfall Experiment

Student Volunteers—Summer 2014

By Casey Dail, Meteorologist

This summer our staff had the privilege of getting to know and working with three college students: Jessica Burns, Samantha Connolly, and Zachary Sefcovic. Jessica is a senior at North Carolina State University. She worked on a sea fog project to improve sea fog pattern recognition along the North Carolina coast. Her research will be used to improve our forecasters synoptic and mesoscale recognition in identifying sea fog events, and ultimately improve short term and marine forecasts. Samantha is a junior at Millersville University in Pennsylvania. This summer she worked on several outreach related videos: rip current safety, Lightning Awareness Week, and improving our office tour presentation. She also helped get our office YouTube account operational, as well as assisting with several outreach events. Zach is a first year graduate student at East Carolina University. He completed his undergraduate studies at Valparaiso University, graduating in May 2014. In addition to spending this summer at our office, Zach spent the summer of 2013 here as well as a Hollings Scholar; during that time he created a Tropical Cyclone Climatology for Eastern North Carolina. This summer he worked on a radar analysis comparing Normalized Rotation (NROT) values to tornado events across the area.

In addition to completing their individual research projects, each student spent many hours shadowing the forecast staff in operations: from launching weather balloons to assisting with forecast updates. They also assisted with surveys and outreach events across Eastern North Carolina. These experiences have reaffirmed each's desire to work for the National Weather Service. We would like to thank these three again for their hard work and wish them best of luck with their future endeavors!

For additional information on or our volunteer program, please visit our webpage http://www.weather.gov/mhx/StudentInterns, or contact Casey.Dail@noaa.gov.

Volunteers—Zach Sefcovic, Samantha Connolly and Jessica Burns

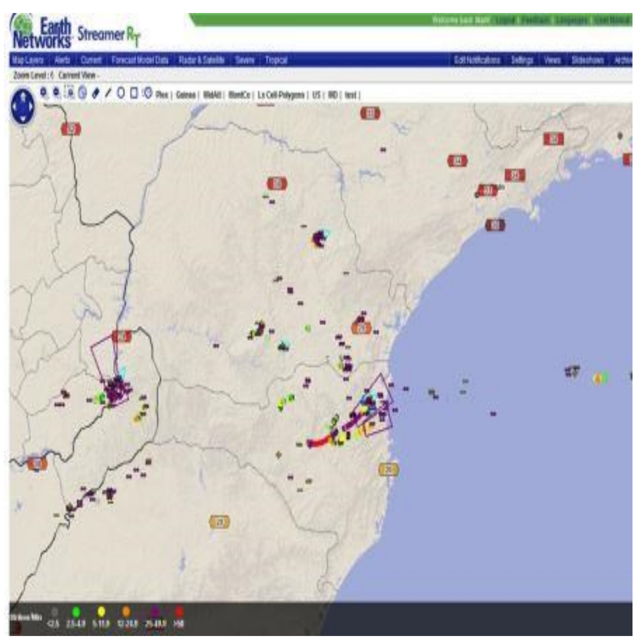
NWS Meteorologists Test Lightning Data

By Tom Lonka, Meteorologist

David Glenn and Tom Lonka, meteorologists from the National Weather Service Newport/ Morehead City office, tested lightning data from the Earth Networks Total Lightning Network (ENTLN). The testing took place at the Hazardous Weather Testbed in Norman, OK in July and August in a controlled environment. The meteorologists worked several convective weather events around the U.S. in displaced real time, and were exposed to a variety of storm modes. The purpose of the testing was to determine if the Earth Networks' Lightning Cell Tracking and Dangerous Thunderstorm Alerts will be useful for warning decisions for forecasters in the National Weather Service.

ENTLN data detects both Cloud-to-Ground (CG) and In-Cloud (IC) lightning flashes. The ENTLN is currently comprised of more than 700 detectors worldwide. Total Lightning refers to IC flashes plus CG flashes. Current research studies are being done to determine whether the number or density of total lightning can help determine whether or not a severe thunderstorm will develop. The Lightning Cell Tracking and Dangerous Thunderstorm Alert polygons are derivative products of ENTLN. Lightning flashes are grouped using a clustering algorithm that is based on the flash rate and density to generate lightning cells. There are three levels of polygons generated based on the lightning cell density. These polygons are called Dangerous Thunderstorm Alerts (DTA). The use of these total lightning derivative products have demonstrated potential for enhancing forecaster situation awareness and longer convective warning lead times. Like any algorithm used by National Weather Service meteorologists, the DTA polygons and Lightning Cell Tracking products from ENTLN are not meant to replace severe weather warning polygons, but rather to supplement forecasters in their warning decision process.

NWS Meteorologists work with Researchers at the Hazardous Weather Testbed in Norman, Oklahoma.



ENTLN Total Lightning, Cell Tracking, DTA Polygons

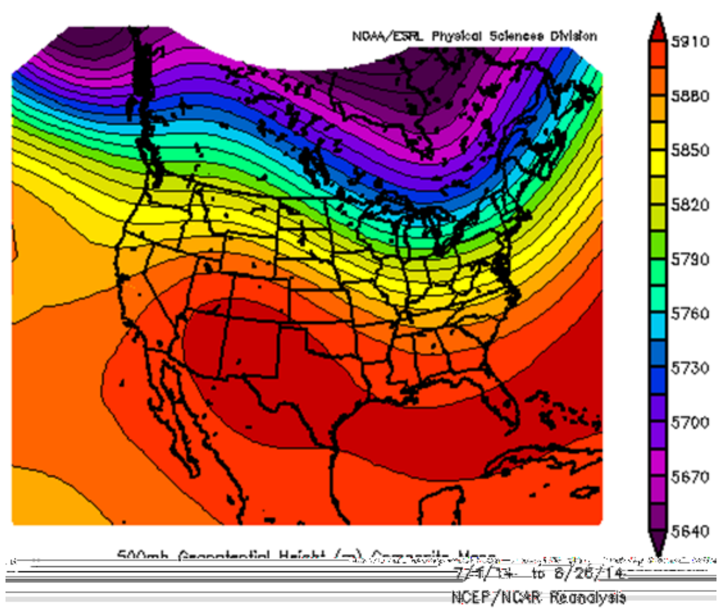
Why Was This Summer So Wet?

By Bel Melendez, Meteorologist

The summer of 2014 has not been your typical eastern North Carolina summer. Most of this summer was rainy and cool, except for the month of June. June started out warm with high pressure dominating the region with the typical summertime thermal trough that developed inland during the month. Average temperatures were near to slightly above normal with average maximum temperatures in the 80s, while average low temperatures ranged from 65 to 71 degrees. There were also typical summertime /sea-breeze induced convection that occurred during the afternoons.

The weather pattern changed as we moved into July. This was not because of Hurricane Arthur, the earliest landfalling hurricane to hit North Carolina, but because the eastern half of the country was under a persistent long wave trough pattern. This pattern resulted in several cold fronts that became stationary which lead to above normal rainfall amounts across our area. During this timeframe, several locations in Eastern NC received rainfall totals around 10 inches. The rainy and cloudy conditions caused the average temperatures across eastern NC to be 3 degrees below normal. Average maximum temperatures were in the mid 80s when typically they should be in the upper 80s; meanwhile average low temperatures were near normal (upper 60s to low 70s).

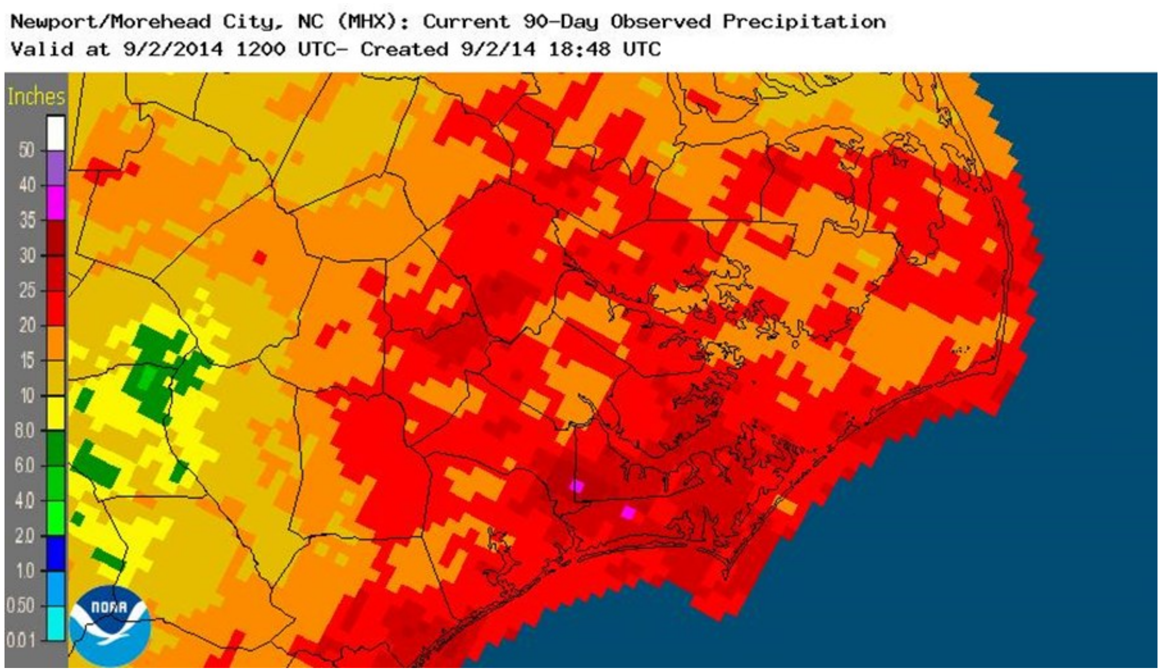
While there were hopes that August would be a different story, the upper level trough persisted until the last week of August. Stationary fronts continue to influence our local weather along with diurnal driven showers and thunderstorms. An additional 6 to 11 inches of rain fell across the area in August and average temperatures were slightly cooler. Normally, eastern North Carolina summers tend to have afternoon showers and thunderstorms along with tropical cyclone affects, but this summer was surely above normal for rainfall.



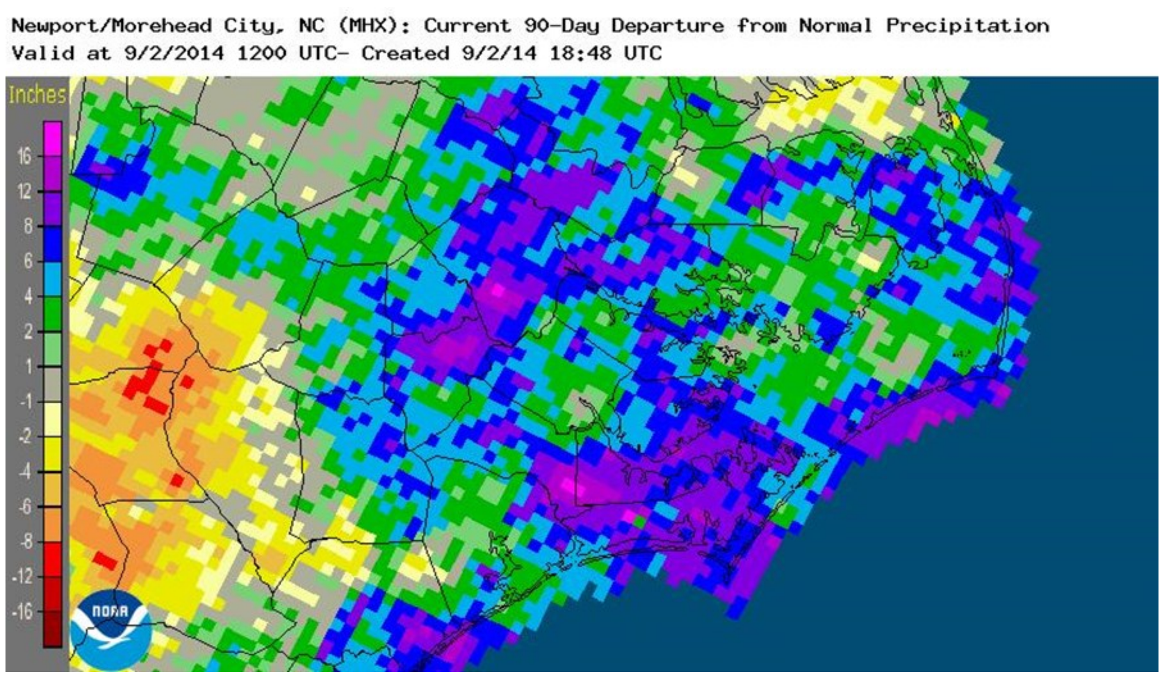
At the mid-levels, a persistent trough was in place for July and August, leading to more rainfall and below normal temperatures.

Why Was This Summer So Wet? (Continued)

Overall, many locations in eastern North Carolina received 15 to 25 inches with a few isolated locations up to 35 inches of rain this summer. As a result, some locations are up to 16 inches above normal!



Observed precipitation for June, July and August, 2014. Some areas had over 35 inches of rain.



Departure from Normal, June through August 2014. Some areas were more than 16 inches above normal.

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