



The Wilmington Wave

National Weather Service, Wilmington, NC

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Spring 2019

Volume IX, Issue I

Hurricane Florence: The Storm of a Lifetime

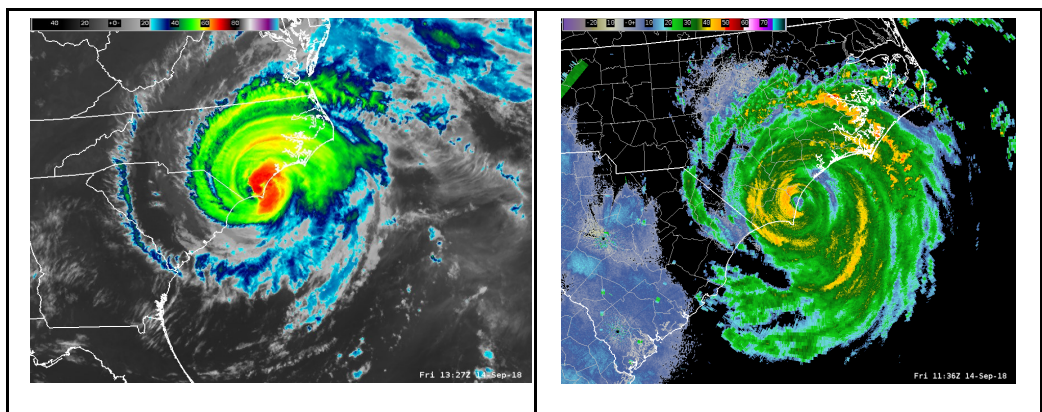
By Tim Armstrong

A tropical depression formed off the west coast of Africa on August 31, 2018. This system strengthened as it moved across the warm tropical Atlantic and on September 4 became Hurricane Florence. Florence took a looping path generally toward the northwest over the next week, at one point becoming the strongest hurricane ever observed so far northeastward in the Atlantic Ocean. Florence's wind speeds peaked at 140 mph on September 10 well away from land, making it a category four hurricane and the second strongest hurricane of the 2018 hurricane season behind Hurricane Michael. Florence then turned westward toward the U.S. East Coast.

Fast Facts for Hurricane Florence in Wilmington, NC

Most rainfall in history: 23.02"
 Highest Cape Fear River Stage: 8.28 feet MLLW
 Second strongest wind gust: 105 mph
(first hurricane force wind since Charley in Aug. 2004)
 Fourth lowest barometric pressure: 28.51 In. Hg

Winds began to increase across the Carolinas during the morning of September 13, and tropical storm force gusts developed along the North Carolina coast during the afternoon. Florence's eyewall, the ring of strongest winds immediately surrounding the eye, crashed ashore in Pender and Hanover counties a couple hours before sunrise on September 14. Wind gusts as high as 105 mph were measured at the Wilmington International Airport; these were the strongest winds measured locally since Hurricane Helene struck the area in 1958.



Satellite and radar images of Hurricane Florence making landfall near Wrightsville Beach, NC during the morning of September 14, 2018. At landfall maximum sustained winds were near 90 mph.



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Although significant property damage occurred from winds and storm surge across the Cape Fear area, Florence's worst impacts were from record-breaking rainfall from September 14 through 16 that led to catastrophic flooding across large sections of eastern North Carolina and northeastern South Carolina. Florence broke the South Carolina record for the most rain associated with a tropical cyclone in Loris with 23.63 inches. In North Carolina 35.93 inches of rain was recorded just northwest of Elizabethtown, also setting a new state record for tropical cyclone rainfall. This extreme rainfall led to flash flooding that inundated neighborhoods and closed roads. Hundreds of people trapped in their homes by rising flood waters across southeastern North Carolina had to be rescued by boat, Humvee, or helicopter.

Water drained into the river system over the following week leading to all-time record stages on most local rivers. Records were broken on the Cape Fear and Northeast Cape Fear Rivers, the Waccamaw River, and the Lumber River. This flooding damaged or destroyed thousands of homes and businesses, some of which had only recently been repaired after flooding from Hurricane Matthew less than two years earlier.

There were 42 fatalities in North Carolina and 9 in South Carolina attributed to Hurricane Florence. Damage estimates reached \$16.7 billion in North Carolina and \$607 million in South Carolina, mainly due to the 85,000 structures that were damaged or destroyed by flooding in the Carolinas.



Florence's largest impact was flooding. Flood-destroyed roads shown here include NC Highway 210 near Moore's Creek (left) and U.S. Highway 421 near the New Hanover-Pender county line (right).



Flooding along the Waccamaw River near Conway, SC was the worst ever seen, exceeding Hurricane Matthew's water depth by four feet. Nearly 1,000 homes were flooded here.

At least 17 tornadoes touched down just within the area served by the Wilmington NWS office. The strongest of these included EF1 tornadoes with 105 mph winds near Sidney in Columbus County, NC.

The eastern portions of North and South Carolina have suffered through five severe floods over the past 20 years: Hurricane Floyd (1999), the late September floods of 2010, October 2015 flooding, Hurricane Matthew (2016), and Hurricane Florence (2018). While it's never possible to blame an individual storm on climate change, the large number of flood events in recent history fit well with impacts expected from a warming climate. Warmer air holds more moisture than cooler air, enabling heavier rainfall to become more common. A warmer climate may also favor weaker atmospheric steering currents that allow heavy rain to fall for longer periods of time. The Fourth National Climate Assessment released in 2014 states "Across most of the United States, the heaviest rainfall events have become heavier and more frequent. The amount of rain falling on the heaviest rain days has also increased over the past few decades."

Need more information on Hurricane Florence?

Go to our Hurricane Florence webpage for a detailed storm history including satellite and radar images, tornado paths, impacts for each county, and rainfall totals for dozens of towns and cities.

Hurricane Florence: September 14, 2018

Current Hazards Current Conditions Radar Forecasts Rivers and Lakes Climate and Post Weather Local Programs

Hurricane Florence: September 14, 2018

News Headlines

- [Florence causes at least 15 deaths in South Carolina](#)
- [Florence causes at least 15 deaths in South Carolina](#)
- [Florence causes at least 15 deaths in South Carolina](#)

Hurricane Florence: September 14, 2018

Current Hazards **Current Conditions** **Radar** **Forecasts** **Rivers and Lakes** **Climate and Post Weather** **Local Programs**

Hurricane Florence, a large and also moving category one hurricane, made landfall during the morning of September 14, 2018. After the eye crossed Wrightsville Beach, NC at 7:15 a.m., the storm spent the next 24 hours pounding coastal North Carolina with heavy rain, strong winds, and a storm surge. The highest rainfall totals were reported by the North Carolina location, exceeding the highest single storm rainfall amounts ever seen in this portion of the state. A station in Lenoir, NC, recorded 23.2 inches of rain falling in one hour. Tropical cyclone rainfall record for the state of South Carolina.

Record one flooding developed over the next several days along the Cape Fear, throughout Cape Fear, Lenoir, and other coastal areas, resulting in major property incidents of homes and businesses. A USGS report indicated river gauge record floods exceeding their 100-year reported return intervals. Although Florence will be remembered primarily for the exceptional flooding, wind gusts over 100 mph caused significant damage to buildings, trees, and electrical poles and wires across the Cape Fear basin, and a storm surge of 10 to 15 feet struck beaches and adjacent property between Cape Fear and Cape Lookout.

The state of South Carolina reported 42 fatalities due to the hurricane and preliminary damage estimates of \$10.7 billion. An estimated 12,123 homes were flooded and 274 people were reportedly rescued from flooding. Nearly 142,000 South Carolinians registered for disaster assistance after the storm. South Carolina Emergency Management reported 8 fatalities across the state, \$467 million damage, 11,300 homes with residents in major damage, 45,000 people evacuated, and 31 cars crushed or totaled.

Historical Impact

A tropical depression developed during the afternoon of August 31 just southeast of the Cape Verde Islands. Becoming better organized, Tropical Storm Florence developed during the early morning of September 1. Florence strengthened into a hurricane, then a major hurricane, while moving northward across the open Atlantic Ocean. Winds peaked at 130 mph on September 5th. Data is missing southward until about 200 miles across the Atlantic. Florence weakened to a 25 mph tropical storm on September 7th while over the central Atlantic 1300 miles southeast of Bermuda.

Due to heavy rain, winds that were extreme for the region, Florence regained hurricane strength on Sunday, September 9th about 150 miles southeast of Bermuda. The hurricane strengthened rapidly on Monday, September 10th with winds increasing to 140 mph. Florence maintained winds of 115-140 mph through Tuesday, September 12th, and began to weaken Tuesday afternoon of Tuesday September 12th due to increasing wind shear and several pulses of dry air pulled into the inner core of the storm.

Map shows wind speed (mph) overlaid using Hurricane Florence

Map shows wind speed (mph) overlaid using Hurricane Florence. The map displays the storm's path from the Atlantic Ocean to the Carolinas, with various wind speed and pressure markers. The map includes a legend for wind speed (mph) and pressure (hPa).

Location	Max Wind (mph)	Location	Max Wind (mph)
Wilmington, NC (port)	100	Shelby County, NC (port)	65
Cape Fear River, Wilmington, NC	99	Lumberton, NC (port)	65
Farmington, NC	89	Coverly Beach, NC	65
Hammonton, NC (USFWS station)	82	Rahok City, NC	65
Wrightsville Beach, NC (2 Moore Park)	80	East Head Island, NC (ECOWest)	65
1-140 near Cape Fear River, NC	84	Fayetteville, NC (port)	65
Condit, NC	82	Fort Bragg, NC	65
Hempstead, NC (Alameda Park)	78	Myrtle Beach, SC (port)	61
Fort Fisher, NC	78	Monroeville, SC	61
Holly Ridge, NC	77	Hampton, SC (port)	61
Cherry Grove Beach, SC	77	North Martin Beach, SC (port)	60

Florence: Tornadoes also developed within the stronger rain bands, dozens of tornado touchdowns were confirmed by NWS Storm Spots network.

off the details top of Hurricane Florence using satellite. Although the general structure of the storm was visible, the top of the storm cloud deck was obscured by the rain. The storm was observed during the morning of September 14, 2018.

Composite side view of Hurricane Florence using satellite. Although the general structure of the storm was visible, the top of the storm cloud deck was obscured by the rain. The storm was observed during the morning of September 14, 2018.

NEARBY LEVELS

2000 ft. WRIGHTSVILLE BEACH, NC
 1500 ft. WRIGHTSVILLE BEACH, NC
 1000 ft. WRIGHTSVILLE BEACH, NC
 500 ft. WRIGHTSVILLE BEACH, NC
 0 ft. WRIGHTSVILLE BEACH, NC
 -500 ft. WRIGHTSVILLE BEACH, NC
 -1000 ft. WRIGHTSVILLE BEACH, NC
 -1500 ft. WRIGHTSVILLE BEACH, NC
 -2000 ft. WRIGHTSVILLE BEACH, NC

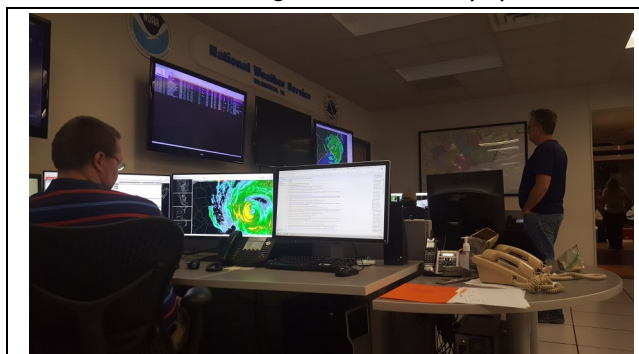
weather.gov/ilm/HurricaneFlorence

NWS Operations During Hurricane Florence

By Victoria Oliva

As Hurricane Florence was making its approach towards the U.S. East Coast, the staff at NWS Wilmington began making plans, both personally and for the office, just in case Florence made landfall in the Carolinas. As the week leading up to Florence progressed, the likelihood of a NC or SC hurricane landfall was increasing. Within a few days prior to landfall, the ILM staff began evacuating their families from the area, either inland or out of state. The office stocked up on water, drinks, non-perishable foods, as much food as our fridge could hold, and plenty of emergency supplies. Since we were expecting Florence to make landfall near our area, and for it to be a prolonged event due to slow storm motion, virtually all of the Wilmington staff made plans to sleep at the office beginning night of September 13th, with no idea how long it would be before we would be able to leave.

On September 13th, the outer bands of Hurricane Florence began affecting our area. The Wilmington office already has extra staff working around the clock to handle critical forecast, warning, and decision support operations.



Meteorologist Jordan Baker and ILM staff worked hard as Hurricane Florence was making landfall at Wrightsville Beach.

Continued on page 4....



Well-stocked kitchen at Wilmington, NWS during Hurricane Florence

NWS staff was busy, with phone calls, issuing products, and our Electronic Technicians lowering all hurricane shutters and keeping an eye on equipment. Since this was the first night we were spending at the office, everyone had to find a spot in the office to catch some sleep: in offices, cubicles, supply room, and even the computer room. Staff slept on cots, air mattresses, and the floor, taking turns between operational periods. In total, close to 20 people were living at the Wilmington, NC office that weekend.

As Florence made landfall the morning of the 14th, operations remained busy yet controlled. One staff member was handling hurricane products, another watching the radar, and then we had conference calls and social media, along with our regularly scheduled products that needed to be issued. Those not on shift found somewhere in the building they could take some downtime to regroup before being needed back on shift. Early on the 14th the office lost commercial power, but thankfully our generator kicked in and held up for the duration of the event.

On September 15th, some staff that lived in Wilmington began to venture out to see if they could reach their homes and check road conditions. Most roads were either flooded or blocked by fallen trees and power lines. Operations remained busy: rain was still falling in the area, tornado warnings were still being issued, and numerous reports were being received. Our staff was able to grill some food to feed everyone and help keep up morale.

On the 16th, the rain was tapering down and operations became more focused on post-storm tasks: fielding calls, media inquiries, and performing storm surveys (at the few locations that were accessible to us due to Wilmington becoming an island). Those of us not on shift but were still staying at the office found things to do away from operations as to not interfere. Staff slowly began vacating the office when possible, some returning to homes with some damage and others to homes with no power. One staff member stayed at the office longer than the rest of the staff due to flooding at his home. By September 20th, operations were almost back to normal. Major river flooding was ongoing (and would continue for a while), keeping the staff hydrologist working hard for weeks following Florence. Roads out of the Wilmington area were still hit or miss and therefore we relied on help from our neighbor offices to conduct surveys of our far-reaching areas, particularly in SC near the Waccamaw River.

The staff here at Wilmington, NC NWS would like to give a shout-out to all of our colleagues that helped us out during Hurricane Florence: **Ken Haydu** (Wilmington, OH WFO), **Mike Efferson** (New Orleans, LA WFO), and **Mike Ekster** (Gray, ME WFO) travelled to our office to lend a hand during hurricane operations, joining shift rotation and issuing warnings. They too had to stay at the office overnight. **Josh Palmer** (Greenville-Spartanburg, SC WFO), **Eric Seymour** (Wakefield, VA WFO), and **Blair Holloway & Jonathan Lamb** (Charleston, SC WFO) all helped conduct post-storm surveys for our area, particularly surveying places the ILM staff couldn't get to due to flooded roads. And finally **John Koch** (Eastern Region HQ) and the **WFO Charleston staff** for providing back-up for our office for two days after Florence cleared the area, allowing us to regroup and handle personal affairs. We can't thank these folks enough for the assist they gave us during a very stressful time.

Thank You!



Charleston NWS forecasters Blair Holloway and Jonathan Lamb on a storm survey on the Waccamaw River near Conway, SC

Sunrise, Sunset, & Science: Forecasting with a Red Sky

By Mike Kochasic

Living near the coast can have many advantages. One benefit to area residents in the Carolinas can be the amazing sunrises and sunsets on display many days of the year. You may have heard the old adage: “Red in the morning, sailors warning. Red at night, sailors delight.” Going back in time hundreds or even thousands of years, authors have referenced the phrase about sunrise and sunset. But is there any truth to the saying?

The saying may actually be related to the science of the atmosphere.

Starting with the basics, weather usually moves from west to east over the United States. This is due to a prevailing wind pattern known as the westerlies. Because of the west to east motion, stormy or unsettled weather usually impacts ships (and points on land) from the west. The colors of the sky that we see are due to the spectrum of light being filtered in the atmosphere. As sunlight passes through the sky, light is split into the different visible spectrums of color as it passes through air. Air also contains water vapor and other dust particles in the air, and



Downtown Wilmington Sunset (photo credit: surfchex.com)

light bouncing off these objects can change the color appearance, too. The amount of particles (dust and moisture) in the sky at any given time are usually related to weather patterns and help determine the color of the sky.

When the sun is low in the sky, visible light passes through a longer distance in the atmosphere than if the sun were straight overhead in the sky. At sunrise or sunset, light passes through the sky and bounces off dust and moisture particles, and the visible light that we see is colored a bright red. We see red because longer visible wavelengths are breaking through the atmosphere, while other colors in the visible light spectrum are scattered and broken up (i.e., makes other colors non-visible). The shorter wavelengths (such as blue, which we see when the sun is more directly overhead), are scattered and broken up at sunrise and sunset when large amounts of dust and moisture are present.

So what does all of that science mean for us?

When we see a red sky in the **morning**, it's possible that a high pressure system (associated with giving the Carolinas good weather) has already moved beyond our location. When a high pressure moves away, it is usually followed by a low pressure system (associated with giving the Carolinas stormy weather). A morning sky that appears bright red could indicate a lot of moisture and dust particles are in the atmosphere. In essence, rain and other unsettled weather could be coming. **Red in the morning, sailor's warning.**

When we see a red sky in the **evening**, the setting sun is sending light through a lot of moisture and dust particles. This usually indicates that high pressure is on its way, which brings good weather. **Red at night, sailors delight.**

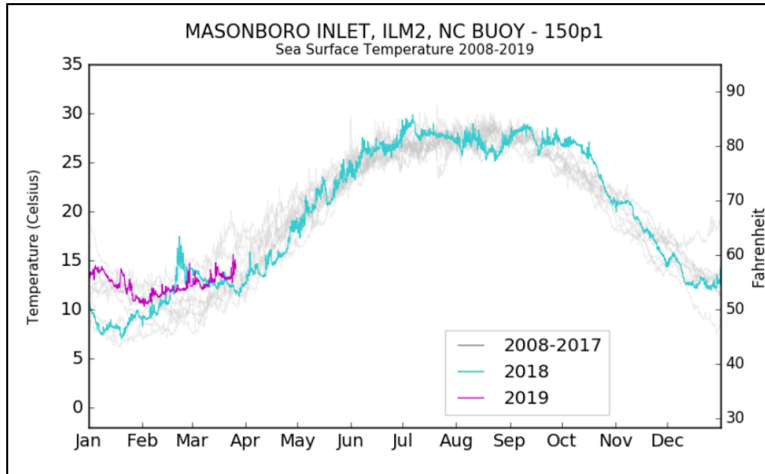
Note: This saying works for the westerlies, which includes locations on the globe (both north and south hemispheres) between 30 and 60 degrees latitude, which includes the Carolinas. So the next time you're enjoying an area sunset (or for the early birds, sunrise!), keep in mind that the color red can be related to what weather may be in store for the Carolinas.

Does the saying always work? No. But there is some scientific explanation for the red color, and it can indicate that sunny or wet weather may be on the way.

A Look at Water Temperatures at the Masonboro Inlet Buoy

By Michael Colby

Buoy is located 5.2 nautical miles SE of Masonboro Inlet

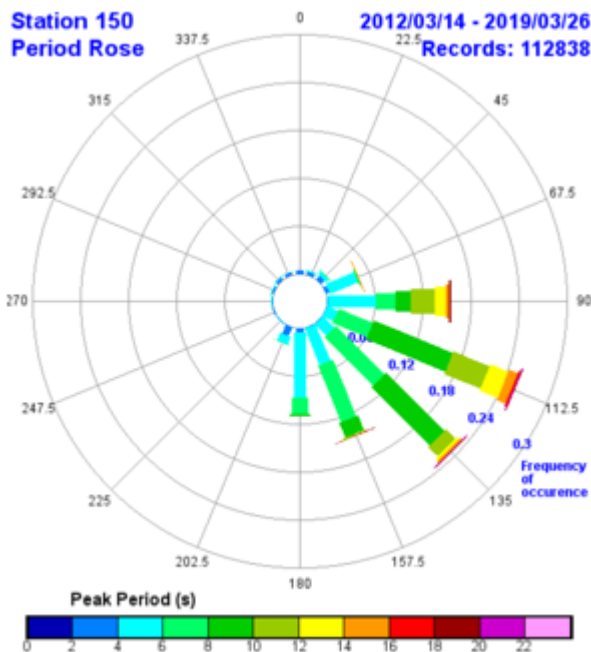


- 2019 sea surface temperatures began milder compared to 2018. 2019 did not have the deep cold like early January 2018 did.
- Unusually warm water was experienced in late September to October of 2018 following Hurricane Florence.
- In 11 years of data, a larger 'range' of temperatures is seen from December through April, when compared to the other months.
- With a few exceptions, the coldest temperatures usually occur in late January to early February, with the warmest waters July and August.

The Wilmington Harbor Buoy

By Michael Colby

The Wilmington Harbor buoy sends and records wave information in an active marine location, south of the Cape Fear and west of a large sand-bar called Frying Pan Shoals. The shoals offer some protection from large seas that arrive from the northeast and east.



What has 7 years of collecting wave data told us?

- The length of the bars are how frequently waves come from that direction.
- The most common wave directions are **ESE and SE**.
- The colors show the dominant wave period, from short period wind waves to long period swells.
- Long period swell from distant locations, most commonly arrive from **E through SSE**.
- Short period wind waves in dark blue, are rarely the dominant wave, commonly arrive from **SSE through E**.
- **SSW** waves show the highest occurrence as 2-4 second wave periods: wind wave and chop.
- **S** waves are common, but very little swell waves arrive directly from this direction.

Wilmington's Weather-Ready Efforts

By Jordan Baker

The Weather-Ready Nation (WRN) Ambassador program is an initiative of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), to strengthen partnerships with external organizations toward building community resilience in the face of increasing vulnerability to extreme weather and water events.

Building a Weather-Ready Nation requires more than government action alone. It requires innovative partnerships with other weather information providers (i.e., the Weather Enterprise), and with organizations across all segments of society for better community, business, and personal decision making. Our WRN Ambassadors here in the Wilmington, NC area help us achieve these goals.

Partners with National Weather Service in Wilmington, NC

Williamsburg County EMS (NC)
 Williamsburg County Fire Department (NC)
 Williamsburg County School District (NC)
 Williamsburg County Sheriff's Office (NC)
 Williamsburg County Transit Authority (NC)
 American Red Cross (Brunswick County, NC)
 Division of Services for the Deaf and the Hard of Hearing, Wilmington (NC) Regional Center
 Carolina Forest Civic Association
 Cape Fear (NC) Public Utility Authority
 Little Town Learning Center
 WMBF News (Myrtle Beach, SC)
 Brunswick County (NC) Emergency Services
 Brunswick County (NC) Schools
 New Hanover County (NC) Emergency Management
 Bladen County Schools (NC)
 New Hanover Regional Medical Center (NC)
 Florence County (SC) Emergency Management
 Greater Pee Dee Skywarn
 Georgetown County (SC) EMD
 New Hanover County (NC) Local Emergency Planning Committee (LEPC)
 City of Florence (SC)
 Marlboro County (NC) E-911/EMD
 University of North Carolina Wilmington

Code Red Emergency Response Team, St. Anne Catholic Parish (SC)
 City of Whiteville (NC) Emergency Services
 Bladen County Times
 Myrtle Beach (SC) Fire Dept
 Marlboro County (NC) EMD
 New Hanover County (NC) Safety Committee
 Grand Strand Medical Center (SC)
 Horry County (SC) Emergency Management
 Socastee High School (SC)
 Windermere Insurance
 CareSouth Carolina
 Beach Services, Ltd.
 Town of Wrightsville Beach Department of Planning & Inspections
 Ant Hill Range
 R H Moore Company
 DeHaven & Associates
 NCDOT (Lumberton District Office)
 Neill Real Estate
 Dillon School District Four
 Global Chasers & Spotters
 The Dillon Herald newspaper (NC)
 Carolina Stormwatch Weather
 Cape Fear Sail and Power Squadron (NC)
 Pender County Master Gardeners (NC)
 Pender County Skywarn (NC)
 Town of Surfside Beach (SC)
 Santee Electric Cooperative
 Southeast Area Technical High School (NC)
 North Carolina National Guard
 Waggin' Tails Pet Supplies and Grooming
 @PeeDee_Wx

USCG Auxiliary Flotilla 070-12-10
 Global Chasers and Spotters
 Coddage HOA
 Cape Fear Rotary (NC)
 Columbus Regional Healthcare System
 Sunny Point Fire Rescue (NC)
 Landfall COA
 Georgia Pacific
 Mazzarone Construction Inc.
 Southeastern Healthcare Preparedness Region (NHRMC-SHPR)
 SPC Credit Union
 PruittHealth Conway at Conway Medical Center
 Sunset Beach Fire Department (NC)
 North Myrtle Beach Ocean Rescue
 Horry County Police Dept - Beach Patrol (SC)
 Lack's Beach Service
 WTXY Meteorologist
 Nakina Fire & Rescue (NC)
 Southeast Fellowship Golf Association
 Southeastern Community College
 De Boone Consulting
 Sigma Iota Omega Chapter (Alpha Kappa Alpha Sorority)
 Town of Surf City (NC)

Partners in association with surrounding NWS Offices

US Army Corps of Engineers Wilmington District
 Goshen Medical Center, Inc.
 VA Medical Center Fayetteville (NC)

Partners in association with the State of South Carolina

State of South Carolina Climate Office

Hurricane Floyd: 20 Years Later

By Tim Armstrong

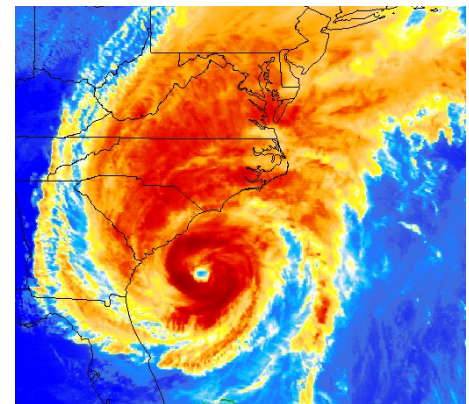
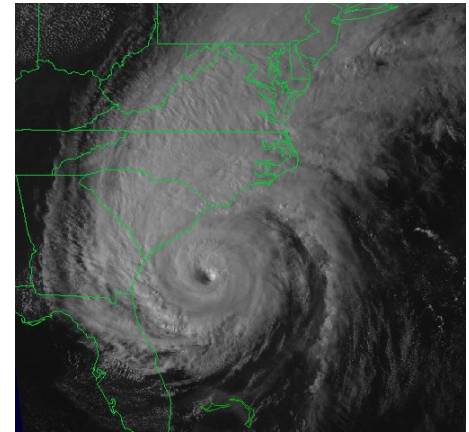
Longtime residents of North and South Carolina won't soon forget the events of September 15 and 16, 1999 when Hurricane Floyd struck the area. Floyd was a powerful storm that reached category four intensity while near the Bahamas, then brought strong winds, record rainfall, and deadly flooding to the Carolinas and Mid-Atlantic region. In North Carolina alone Floyd was responsible for 35 fatalities with insured losses over \$1.3 billion. In all, Floyd's 57 fatalities made it the deadliest U.S. hurricane in over 25 years. Damage amounted to \$6.9 billion from the Bahamas to the Carolinas to New England.

Floyd became a tropical depression on September 7, 1999 while in the Atlantic Ocean between Africa and South America. Over the next several days the storm strengthened into a powerful hurricane while moving northwestward across the warm ocean north of the Caribbean Islands. At its peak, Floyd was producing wind speeds of 155 mph.

Floyd's eye moved directly across Great Abaco Island in the Bahamas during the afternoon of September 14 while still moving northwestward. Since it wasn't certain precisely when Floyd would complete its turn to the north, a massive evacuation effort was organized along the East Coast from Florida into the Carolinas. News reports estimated between 2.6 and 3 million people packed up and fled ahead the storm. Landfall occurred just before 3 a.m. on September 16 near Cape Fear, NC with maximum sustained winds of 105 mph – still a category two hurricane. Floyd's winds diminished further as it moved across eastern North Carolina and accelerated northeastward along the Mid-Atlantic coast. The National Hurricane Center reported up to a ten foot storm surge occurred along portions of the North Carolina coast.

Hurricane Floyd certainly dropped enough rain by itself, 10 to 20 inches, to cause severe flooding, but about two weeks earlier Hurricane Dennis dropped six to 18 inches of rain across parts of eastern North Carolina. The combination of heavy rainfall from both systems led to catastrophic river flooding that devastated communities along the Tar, Neuse, Waccamaw, and Northeast Cape Fear rivers. Large swaths of land across eastern North Carolina and Virginia well outside of established flood plains were inundated for days or weeks after the storm. According to the Wilmington Star-News, Hurricane Floyd damaged 56,000 homes and cancelled local schools for over 2 ½ weeks. Wilmington was isolated due to flooding for several days, a scene that would play out again in 2018 when Hurricane Florence brought exceptional rainfall and flooding.

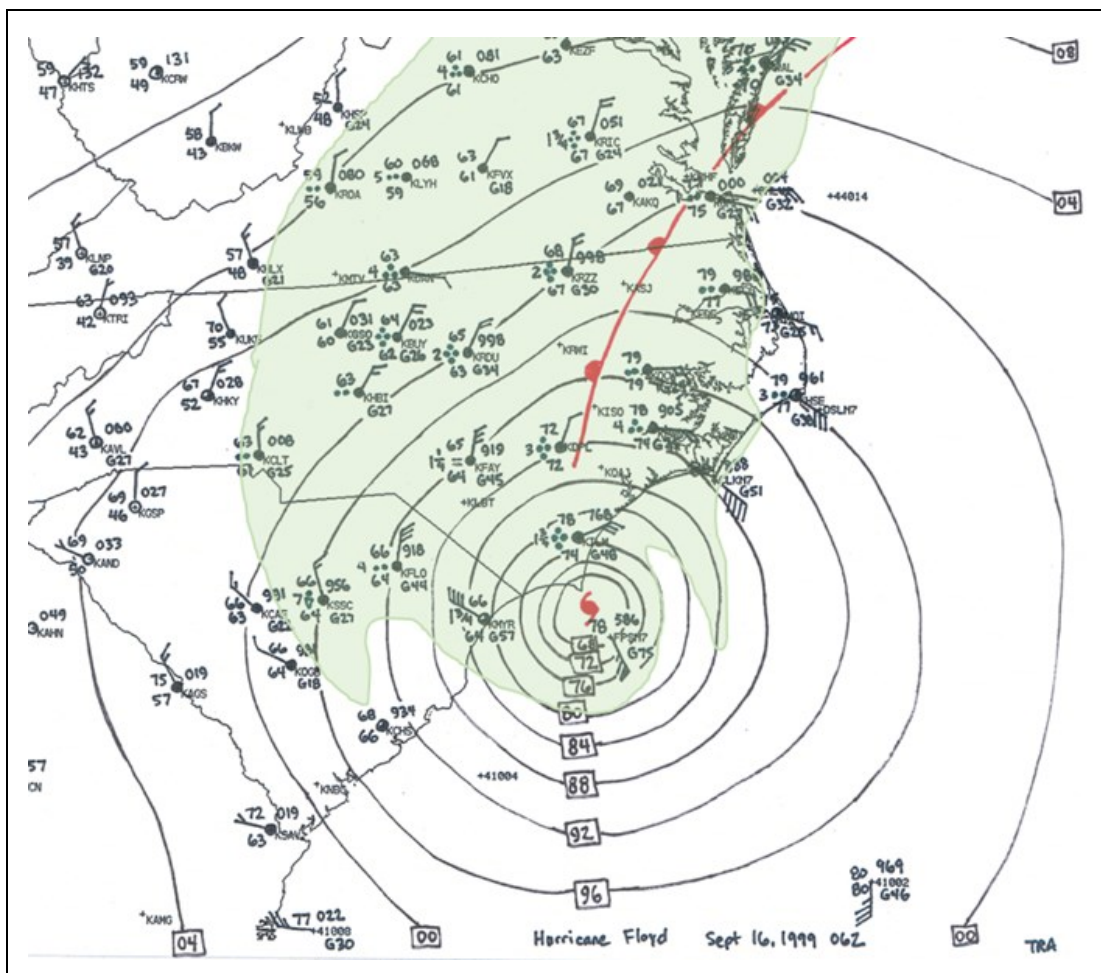
Measured by its barometric pressure, Floyd is the most powerful hurricane to strike Wilmington since official records began in 1874. The barometer at the Wilmington airport dipped as low as 28.34 inches of mercury (959.7 millibars) which is lower than the pressures recorded during Hurricanes Fran (1996), Donna (1960), or Florence (2018). Although Hurricane Florence dropped the most rain of any weather event in Wilmington history (23.02 inches), Floyd still holds the record for the most rain in a single day, 13.38 inches, on September 15, 1999. Floyd's wind gusts at the Wilmington airport reached 86 mph, but were measured as high as 112 mph at Frying Pan Shoals Tower, and 126 mph on Topsail Beach.



Visible (top) and Infrared (bottom) satellite imagery of Hurricane Floyd as it approached the Carolina coast on Sept 15, 1999.

Continued on page 9...

Floyd was the last in a series of four devastating North Carolina landfalls that occurred during the latter half of the 1990s when hurricanes Bertha, Fran, Bonnie, and Floyd all struck within a four year period. The only other similarly active period for landfalling hurricanes in the Carolinas occurred during the 1950s when Hazel, Diane, Ione, and Helene affected the area.



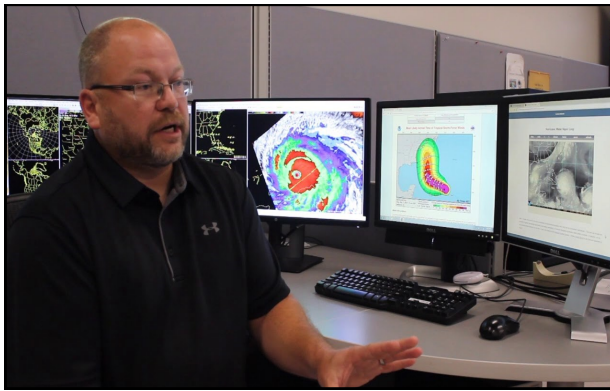
Want to share your Hurricane Floyd stories?

One of our meteorologists is working on a history webpage for Hurricane Floyd and would like to include your local stories, pictures, or recollections of this historic weather event. If you lived in eastern North or South Carolina in 1999 and would like to add your Floyd memories for future generations to read, please email Tim Armstrong at timothy.armstrong@noaa.gov

Outreach: Beyond the Science

By Jordan Baker

One of the many jobs of the National Weather Service is to educate the public about the science regarding weather forecasting and how the public can protect themselves in weather emergencies. The National Weather Service here in Wilmington, North Carolina serves 13 counties in North and South Carolina. Throughout the year, our meteorologists are in various areas around the region in cities like Wilmington, Myrtle Beach, Florence, Lumberton, Georgetown, Darlington, and every town in between. Our office participates in Skywarn classes, school events, science fairs, festivals, conferences, and presentations to local interest groups. We also give office tours and presentations which provide information on how and why we do our job.



Meteorologist Steve Pfaff educates students on weather safety ahead of an approaching hurricane

Do you know what to do when severe weather strikes? While the answer to this question is likely yes, some residents don't know how to react in severe weather situations. That's where we step in! We provide valuable information to the public regarding how to interpret the information that we transmit and how to act when that information is received. From tornadoes, hurricanes, fires, floods, and tsunamis, our meteorologists give presentations all across our region to promote preparedness in your home before the next weather disaster. At many local festivals and community events, we also organize booths and tables with preparedness information and brochures so that you have open and free access to the information without having to attend a presentation.

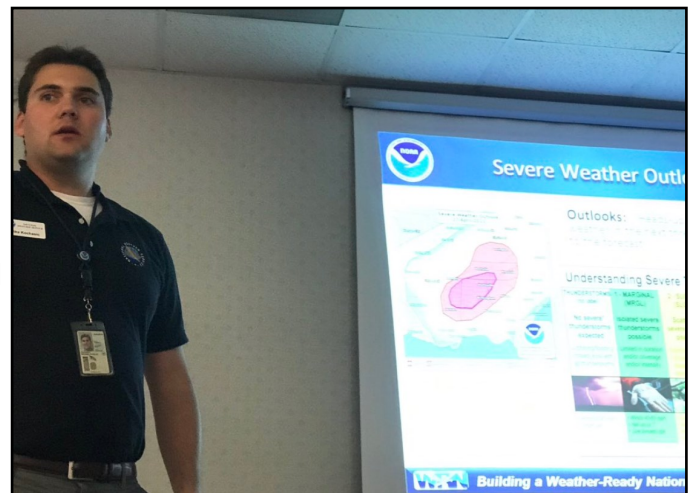
Creating a Weather-Ready Nation

At the heart of every outreach event, we are attempting to create a Weather-Ready Nation. This means creating a community that is ready, responsive, and resilient when severe weather occurs. Our efforts to work with the public and your county officials focus on making sure that every person is prepared for severe weather. By doing this, we hope to limit the impact that hazardous weather has on the community we serve. For more information on your role as a Weather-Ready Nation supporter, visit:

www.weather.gov/wrn

Value to the Public

Do you know what to do when severe weather strikes? While the answer to this question is likely yes, some residents don't know how to react in severe weather situations. That's where we step in! We provide valuable information to the public regarding how to interpret the information that we transmit and how to act when that information is received. From tornadoes, hurricanes, fires, floods, and tsunamis, our meteorologists give presentations all across our region to promote preparedness in your home before the next weather disaster.



Meteorologist Mike Kochasic gives a presentation to a group in Whiteville, NC attending an annual Skywarn class.

Continued on page 11...

Encouraging a New Generation of Scientists

Visits to schools, science fairs, and educational events are all part of the National Weather Service's goal to inspire young minds to pursue scientific disciplines, including meteorology. Our parent organization, NOAA, educates the public in disciplines of engineering, information technology, meteorology, oceanography, mathematics, and social science to promote further scientific exploration and implementation. The purpose of this is to build awareness, develop relationships, and inspire the public to pursue further learning opportunities.

At the local level, our office works with local schools to host tours of the National Weather Service office, give presentations, and be an ambassador to any who are curious about our role in the community.



NWS Wilmington Meteorologist Victoria Oliva talks with a curious student about weather and careers for Women in Science at the North Carolina Aquarium at Fort Fisher in Kure Beach, NC.

Online Resources for Self-Education



[Thunderstorms](#)



[Floods](#)



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[Beach Hazards](#)



[Winter Weather](#)



[Rip Currents](#)



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[Heat](#)



[Hurricanes](#)

Safety information regarding all of the above topics and more can be found at:

www.weather.gov/safety

Q & A with the new Meteorologist-in-Charge!



Mark Willis joined the Wilmington NWS team in March 2019 as the new Meteorologist-in-Charge at our office. The Meteorologist-in-Charge (MIC) is the top position held at a NWS WFO. The MIC's job is to make sure the office is running efficiently and has many functions, including scheduling and personnel management. The MIC can also fill in as a forecaster if needed. Mark agreed to answer a few questions for our newsletter to help introduce himself to our community:

Q: How did you become interested in weather?

A: I became fascinated with weather through surfing when I was younger. Quite frankly, I got sick of going to the beach with my surfboard just to arrive to a flat ocean. So I became very interested in the fundamentals of wave forecasting at a fairly young age. In addition, my family had a home on the Outer Banks where I spent a good chunk of my childhood. The Outer Banks is a fascinating place for all types of weather which helped trigger my weather interest. I can vividly remember helping my grandfather board up our cottage during approaching hurricanes. I was also extremely interested in winter weather growing up. My hometown, Yorktown, VA, often found itself near (but unfortunately typically south of) the rain/snow line which always generated excitement for me growing up.

Q: What was your career path in meteorology?

A: I did my undergraduate work in Meteorology at Florida State University, and my graduate work at the University of Hawaii at Manoa. My thesis involved both infrasonic waves in the atmosphere and ocean wave modeling. It was really in grad school where I learned the most about waves and marine forecasting which has driven quite a bit of my career. I'll be the first to admit that I've followed a somewhat unorthodox career path that has led me to this great office in Wilmington, NC. I spent the first five years of my career as a marine forecaster for the popular recreational website Surfline.com. Then for the better part of the next decade, I was with the National Weather Service where I spent time as a forecaster on both coasts of the U.S. and the National Hurricane Center, before becoming the Marine Program Manager at NWS Eastern Region Headquarters in Long Island, NY. Then a really unique opportunity hit me unexpectedly to head back to Surfline as the Chief Meteorologist/Director of Forecasting. I was in that role from roughly 2012 to early 2019 where I managed a large team of global meteorologists and was responsible for the forecast roadmap, performance, and business objectives of the department. I got to do a ton of fun stuff in that role, including leading a research effort that helped get surfing into the 2020 Olympics in Japan.

Q: What is it about the National Weather Service that appeals to you?

A: Hands down, it is the mission. There is no better feeling in the world than knowing you are helping protect life and property from hazardous weather.

Q: What excites you the most about being the MIC at the Wilmington, NC office?

A: The staff! There is a ton of talent in this office and it's going to be exciting to see how we evolve and find new ways to meet the demands of our customers over the next several years.

Q: What is your favorite type of weather?

A: I really like it all, but marine weather is my forte especially ocean wave forecasting. Tropical meteorology/hurricanes is probably a very close second though.

Q: What was the most memorable event you worked?

A: There were a couple of tornado events I'll never forget when I was a forecaster at NWS Morehead City, NC, and a couple of huge surf events I dealt with at Surfline, but the most memorable event for me was Hurricane Irene in 2011. The part I'll remember the most is coordinating the storm surge forecast for New York City, which was no easy task but great experience.

Q: What do you enjoy doing in your spare time?

A: Spending time with my family, surfing and convincing myself that Florida State Football will get back to where they were in the 90's :)

Want to Become a Weather-Ready Nation Ambassador?

By Steve Pfaff

It's no surprise for many that live in southeast NC and northeast SC that we are susceptible to a wide variety of weather impacts. In fact, our part of the country is like no other when it comes to the different hazards we have to prepare for including wind driven wildfires, hurricanes, ice storms, flooding, tornado outbreaks, severe thunderstorms, drought, etc. Although many of these events do not occur routinely, if we fail to plan for them then many will become caught off guard by their impacts. The National Weather Service (NWS) is responsible for doing storm survey assessments of areas hit hard by severe weather, and a common theme we hear from those who were hit hardest is – "I can't believe this happened to me". While most people agree that we have an exposure to hazardous weather, only a small segment of the population is ideally prepared to deal with extreme weather events.

During a typical year the United States has 100,000 severe thunderstorms, 5,000 floods and flash floods, 1,000 tornadoes, and 2 land-falling hurricanes. It's no wonder why our Nation needs to be Weather-Ready. While there have been advancements in weather related technology and research that have led to the increased accuracy and warning lead time over the last decade, people are still being killed in great numbers. For instance, during 2011 there were 549 fatalities from tornadoes – almost 300 people during the Alabama outbreak on a single day! As a result, the NWS has started a new program called Weather-Ready Nation to enhance community resilience in the face of extreme weather events across the Nation.

The Weather-Ready Nation Ambassador program is the initiative that recognizes a wide variety of partners in their efforts to advocate weather safety and planning. The Ambassadors help to unify weather safety efforts, are action-oriented, inclusive, and help lead to new partnership opportunities with the NWS. The Ambassador program is open to any club, organization, company, civic group, or government agency (Local/State/Federal) and is free to join. There are no formal guidelines or requirements to become an Ambassador other than to sign-up and become integrated into the pipeline of weather safety information through the Weather-Ready Nation program. Consider the following - does weather potentially impact your family, friends, club members, staff or coworkers? If you answered yes then consider joining to become a Weather-Ready Nation Ambassador. Help the NWS to better serve our local communities by signing up!

For more information, and to apply to become a WRN Ambassador, visit: <https://www.weather.gov/wrn/about>



Tornadoes, Lightning, and Flooding, Oh My...

By Jordan Baker

No one is immune to severe weather hazards in the United States. Every state including Alaska and Hawaii has recorded lightning strikes, tornadoes, severe winds, and flooding in association with thunderstorms. Each of these hazards accounts for dozens of deaths across the United States each year. In 2018 alone, 87 people were killed due to flash flooding, 20 were killed due to lightning strikes, 10 were killed due to tornadoes, and 58 were killed by damaging winds caused by a combination of thunderstorms and tropical cyclones. Thunderstorms are very dangerous natural occurrences and they cannot be prevented, however, you can prepare yourself with knowledge and plan of how to act when severe weather eventually threatens you.

Flooding

An average of 95 people die each year due to flooding (in 2018, flooding claimed 87 lives). Almost all of these fatalities have occurred in vehicles attempting to traverse a flooded roadway. If you encounter a situation where you think it is wise to cross a flooded roadway consider this:

- As little as 6" can move you and your vehicle off of the road
- Has the road been washed away underneath? How can you be sure?
- Is the destination worth your life when most flash flood threats last only 3 hours?

How to Prepare...

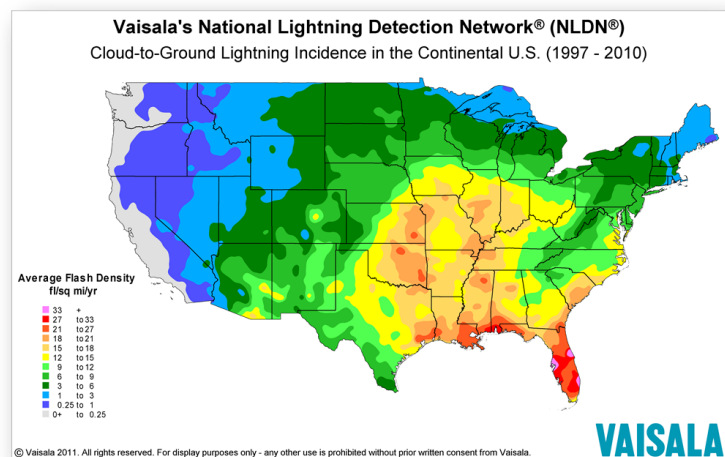
- Turn Around, Don't Drown!
- Don't Allow Kids to Play Near Drainage Ditches
- Know Your Flood-Safe Zone and Prepare a Plan to Move There Quickly

Lightning

While Florida, the Gulf Coast, and the Midwest are the most frequently struck regions in the United States, North Carolina and South Carolina are 5th and 16th, respectively, in lightning strike deaths per year. Many of these deaths occur on beaches and in parking lots, miles away from the thunderstorm producing the strike.

How to Prepare...

- Get inside!
- Get out of the water if you are in a pool or the ocean
- DO NOT stand under trees for shelter when you see lightning or hear thunder
- If you're at the beach or outside away from home, evacuate to a metal-topped, enclosed, vehicle



Continued on page 15...

Damaging Wind & Hail

One of the most unpredictable and most common severe weather hazards is damaging wind. At the end of a storm's life cycle, damaging gusts of winds are produced at the surface as the large amount of rain and hail can no longer be elevated by the storm's updraft. So, what goes up, must come down! Within these "downdrafts", hail can also be present. In cases where hail is large, severe damage can occur. In fact, hail is the costliest hazard in the United States, contributing to ~\$2 billion worth of property damage each year.

How to Prepare...

- Don't stand near external walls or windows during thunderstorms
- Keep dead or dying trees trimmed or removed from your yard.
- DO NOT walk near or run over downed power lines
- If caught outside, seek shelter or a vehicle with a metal roof



Tornadoes

Tornadoes vary far and wide across the United States. Tornadoes in the Great Plains and the Gulf Coast can become large and very powerful. In North and South Carolina, the occurrence of "significant tornadoes" (EF-2 or greater according to the Fujita scale, with winds 120+ mph) is rare. However, of the total tornadoes reported in NC/SC, about 15% are "significant" and these tornadoes account for about 95% of tornado-related fatalities in our area. About 85% of the total tornadoes have wind speeds less than 100 mph and contribute to about 5% of tornado-related deaths. Nevertheless, we can easily be prepared for tornadoes by taking these simple and necessary steps:

How to Prepare...

- Get to the smallest interior room on the lowest level of your home (your safe place)
- DO NOT shelter in a room with windows
- Make sure your safe place has a cell phone or other communication device readily available
- If you live in a mobile home, evacuate, and seek shelter in a home with a foundation. If this is unavailable, seek shelter in a non-flooded ditch.



Beach Safety & Surf Forecast

By Victoria Oliva

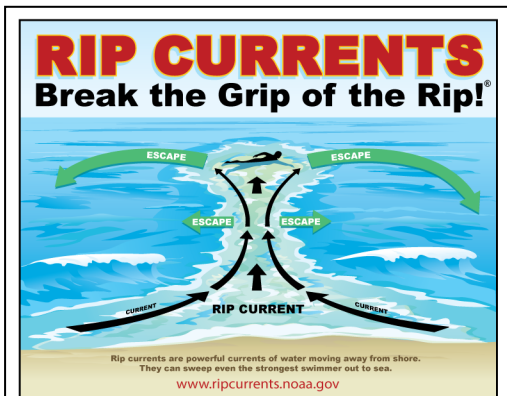
Many hazards exist year-round at North and South Carolina beaches. These include heat, lightning, rip currents, rough surf, environmental hazards, and biological hazards such as jellyfish and sharks. Being informed about these hazards prior to going to beach can help keep you and your family safe. For a great article on the various dangers at the beach and tips to stay safe, visit the NOAA Beach Safety Story Map: <https://www.noaa.gov/stories/story-map-play-it-safe>.

In 2018, there were 18 surf zone fatalities in North and South Carolina, 10 of which were attributed to rip currents. What exactly are rip currents? They are narrow channels of flowing water directed away from shore that develop at beaches with breaking waves. As the waves create a build-up of excess water near the shoreline, rip currents may develop in channels between sandbars. Rip currents are fairly common at our local beaches, and while some days they are too weak to pose a significant hazard, strong rips can travel at speeds faster than an Olympic swimmer!

A common misconception about rip currents is that they pull you under the water. In reality, a rip current is a surface current that carries people away from shore. If you find yourself caught in a rip, **do not** swim against the current (i.e., swim directly towards shore) as this will only exhaust you. Instead swim parallel to the shoreline in order to escape the current, and then swim back to shore at an angle away from the rip. If you become exhausted, tread water or float and wave/yell to get the attention of people onshore.

If you see someone else at the beach caught in a rip current and needing assistance, best course of action is to immediately notify a lifeguard or beach patrol, as they are trained and equipped to rescue swimmers in distress. Sadly, some rip current victims end up being good citizens who try to rescue others without taking proper flotation devices to ensure their own safety. This highlights the importance of swimming in areas monitored by lifeguards.

Remember to never swim alone at the beach and always try to swim near lifeguards. Heed warning flags, signs, and verbal commands of lifeguards and local law enforcement. Avoid swimming near jetties and piers, as rip currents commonly develop near these structures. Don't swim in the ocean at night.



IF CAUGHT IN A RIP CURRENT

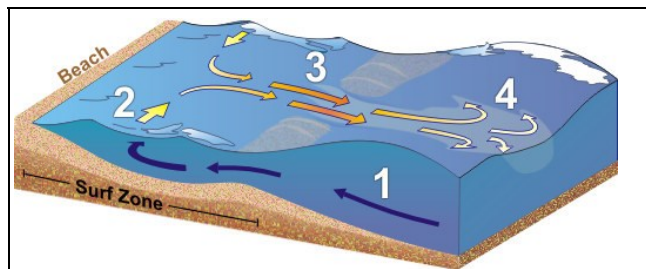
- ◆ Don't fight the current
- ◆ Swim out of the current, then to shore
- ◆ If you can't escape, float or tread water
- ◆ If you need help, call or wave for assistance

SAFETY

- ◆ Know how to swim
- ◆ Never Swim alone
- ◆ If in doubt, don't go out

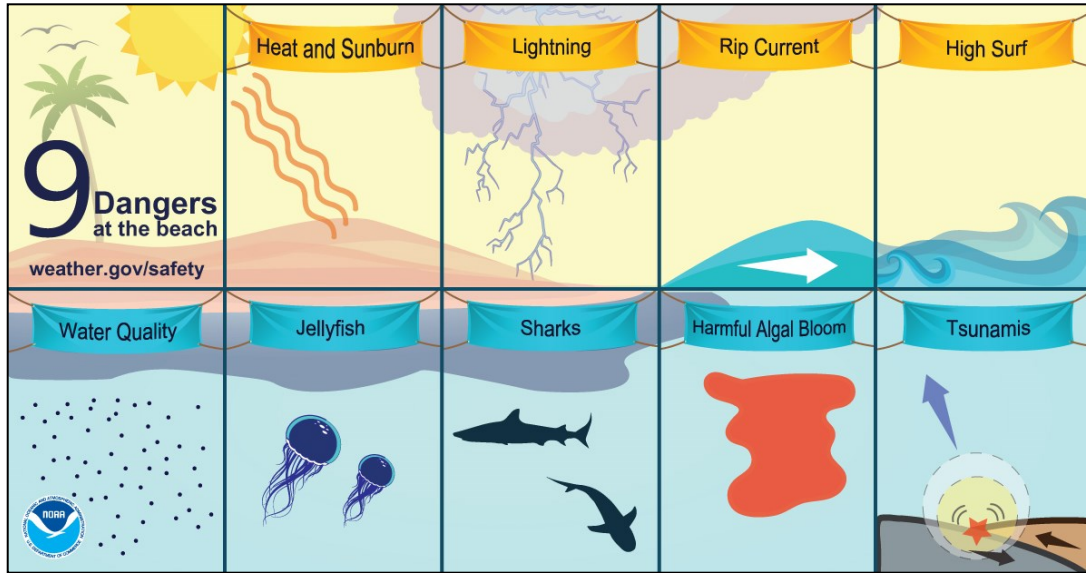
More information about rip currents can be found at the following web sites:

www.ripcurrents.noaa.gov
www.usia.org



Anatomy of a rip current: (1) Incoming breaking waves increase water level nearshore (2) The feeder - water flows alongshore towards a rip (3) The neck - the rapid flow of excess water away from the beach (4) The head - the flow disperses past the breaking waves.

Continued on page 17...



Did you know the National Weather Service issues Surf Forecasts for all local beaches? We issue our Surf Forecast twice a day - in the morning by 5:30am and in the evening by 8:30pm (for the next day’s forecast). The product is broken up into 5 sections - one for each coastal county in our area. It includes numerous forecast variables that every user should be aware of before visiting the beach. These include rip current risk, ultraviolet exposure risk, and surf height, as well as the weather forecast for the area. The Surf Forecast may also include additional hazards, such as expected longshore current strengths or other potentially harmful surf conditions. NWS works closely with local beach partners, including lifeguards at Myrtle Beach, North Myrtle Beach, Wrightsville, and Carolina Beaches, as well as Sunset Beach Fire Department, to continuously improve our surf forecasts and help our community. There are several ways you can access the current Surf Forecast this summer before going to the beach. One way is go to weather.gov/beach/ilm to view current rip risks and click for more detail. Another way is to search for “NWS ILM SRF” in your web browser. Our main webpage also has a link to all recent text products. Or, you can simply scan the QR code below to access the latest SRF product.

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NCZ108-232100-
Coastal New Hanover-
Including the beaches of Wrightsville Beach, Masonboro Island,
Carolina Beach, Kure Beach, and Fort Fisher
429 AM EDT Tue Apr 23 2019

.TODAY...
WEATHER.....Sunny.
HIGH TEMPERATURE....In the mid 70s.
WINDS.....West winds around 10 mph shifting to the south
              in the afternoon.
SURF HEIGHT.....2 to 3 feet.
WATER TEMPERATURE...Mid 60s.
ULTRAVIOLET INDEX...Very High.
LIGHTNING THREAT....None.
RIP CURRENT RISK....The potential for life threatening rip currents
              is low. However rip currents can still occur,
              especially near inlets, groins, jetties and
              piers.
WATERSPOUT THREAT...No Waterspouts.
OTHER HAZARDS.....Moderate south to north longshore current.
    
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CoCoRaHs Needs You!



Ever wonder how much rain fell during a thunderstorm at your house, or how much snow fell during a winter event? Do you have an interest in weather and would like to help your local community, as well as scientists and others interested in precipitation? Then CoCoRaHs is for you! CoCoRaHs, the Community Collaborative Rain, Hail and Snow Network, is a unique, non-profit, community-based, high density network of individual and family volunteers of all ages and backgrounds, who take daily measurements of rain, hail and snow in their backyards. CoCoRaHs is continuously looking for new volunteers to help expand the national precipitation observation network.

How did CoCoRaHs begin? CoCoRaHs came about because of a devastating flash flood that hit Fort Collins, Colorado in July 1997. A very localized storm dumped over a foot of rain in several hours, while other portions of the city had only modest rainfall. The ensuing flood killed five people and caused \$200 million in damages. With this in mind, CoCoRaHs was born in 1998 with a few dozen volunteers. As more volunteers participated, rainfall maps could be produced for every storm showing fascinating local patterns that were valuable both for scientists and for local residents.

Did you know many of the rainfall totals we collected after Hurricane Florence came through the CoCoRaHs program? In fact, the record rainfall measured during Florence was from a CoCoRaHs volunteer observer, a staggering 35.93" near Elizabethtown that also set the NC state tropical cyclone rainfall record. A CoCoRaHs observer in Loris, SC measured 23.63" during Florence, which became the new SC state tropical cyclone rainfall record. There are currently **184 active** CoCoRaHs observers in the Wilmington, NC NWS county warning area. However, several of our counties, including Marion SC and Bladen NC, only have a few active observers each.

So how can you join CoCoRaHs? It only takes four simple steps: register online at www.cocorahs.org, view online training slideshow, purchase a rain gauge, and record and report observations. Volunteers may obtain an official 4-inch rain gauge through the CoCoRaHs website for about \$31 plus shipping. Volunteers post their daily observations on the CoCoRaHs website, or using the free mobile app. Observations are immediately available in map (data.cocorahs.org/cartodb) and table form for scientists and the public to view. The process takes only five minutes a day and gives you the chance to participate in real "hands-on" science. You may be amazed at what you will learn as you become more aware of the weather that impacts you and your neighbors.



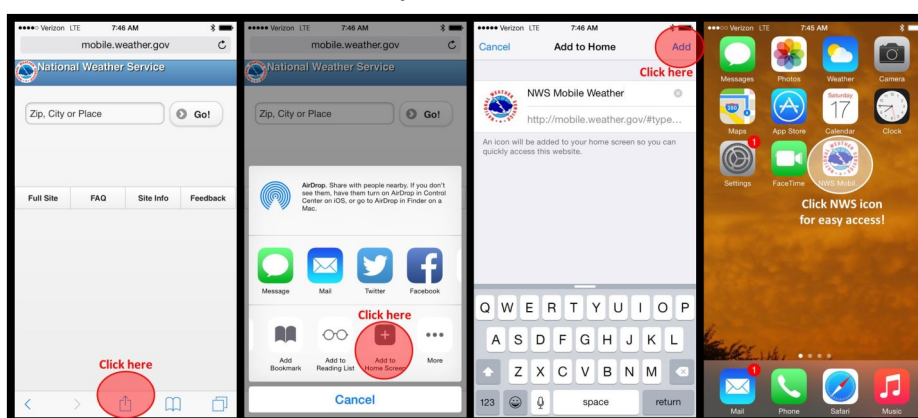
Weather.gov on Your Mobile Phone

Take the weather with you on your mobile phone! Wherever you are, you can get the local weather forecast from the National Weather Service with one click on your home screen. Bookmark **mobile.weather.gov** to make sure that you have the latest weather news and information on the go.

How can you add mobile.weather.gov to your mobile phone's Home Screen? It's easy!

If you have an iPhone...

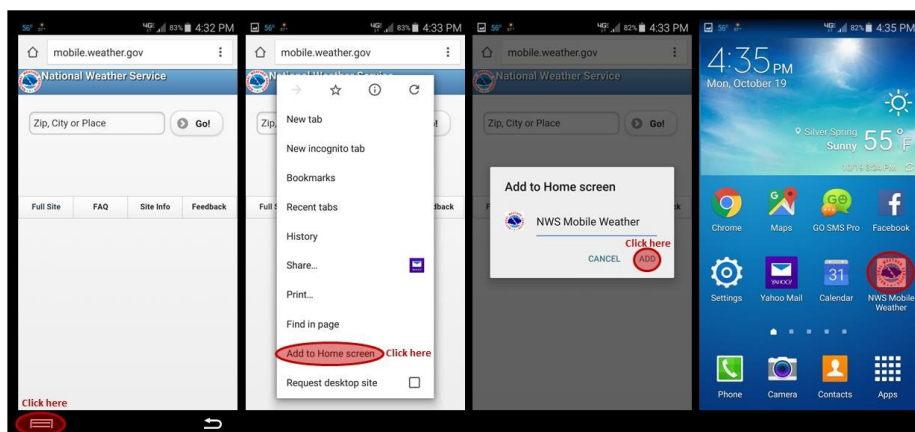
Visit mobile.weather.gov using Safari on your iPhone. Click the Send button at the bottom of the screen. Choose "Add to Home Screen" and tap "Add." - Voilà!



If you have an Android mobile device...

There are a number of browsers that will allow you to add NWS page to your home screen. For example, on Chrome for Android:

Visit mobile.weather.gov using Chrome on your Android phone. Click the menu button and Choose "Add to Home Screen." - Voilà!



That's it! That's all it takes to get local weather information from the NWS on your phone. For other mobile platforms, open your browser and search "how to bookmark a page on ____" with the blank being filled in with your model of phone.

National Weather Service
Weather Forecast Office
Wilmington, NC

2015 Gardner Drive
Wilmington, NC 28405
Phone: (910) 762-4289
www.weather.gov/ilm

Webmaster's Email:
ILM.webmaster@noaa.gov

Understanding Severe Weather Outlooks - Issued by the SPC:

THUNDERSTORMS (no label)	1 - MARGINAL (MRGL)	2 - SLIGHT (SLGT)	3 - ENHANCED (ENH)	4 - MODERATE (MDT)	5 - HIGH (HIGH)
No severe* thunderstorms expected	Isolated severe thunderstorms possible	Scattered severe storms possible	Numerous severe storms possible	Widespread severe storms likely	Widespread severe storms expected
Lightning/flooding threats exist with all thunderstorms	Limited in duration and/or coverage and/or intensity	Short-lived and/or not widespread, isolated intense storms possible	More persistent and/or widespread, a few intense	Long-lived, widespread and intense	Long-lived, very widespread and particularly intense
					
• Winds to 40 mph • Small hail	• Winds 40-60 mph • Hail up to 1" • Low tornado risk	• One or two tornadoes • Reports of strong winds/wind damage • Hail ~1", isolated 2"	• A few tornadoes • Several reports of wind damage • Damaging hail, 1 - 2"	• Strong tornadoes • Widespread wind damage • Destructive hail, 2" +	• Tornado outbreak • Derecho

The Wilmington Wave

Volume IX, Issue I

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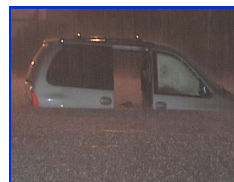
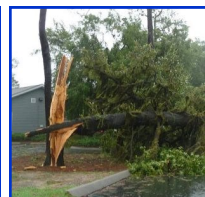
WE NEED YOUR STORM REPORTS!

Events of tornadoes, hail, damaging winds,
and flooding are very important to us.

Please call: 1-800-697-3901

Storm reports **ONLY**

Email: ilm.wxreports@noaa.gov



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