



The Wilmington Wave

National Weather Service, Wilmington, NC

Fall 2019

Volume IX, Issue II

INSIDE THIS ISSUE:

KLTX: A Look Inside	1 - 5
Hurricane Dorian	6 - 8
Dorian Made Waves	9 - 12
2019 Surf Season Summary	13
Winter Weather Tips	14 - 15
EveryThing: Q&A with an Electronics Technician	16 - 18
Weather Ready Nation	19
Social Media Notifications	20 - 21

KLTX 25th Anniversary: A Look Inside

By: Chris McDermott

The WSR-88D, or Weather Surveillance Radar 1988, Doppler, was installed for the Wilmington area in 1994. This was part of a national project to replace aging weather radars and to provide overlapping coverage with surrounding radars. This strategic placement is the reason our radar is in Shallotte instead of by our office. It is placed to provide the best coverage between our surrounding radars in Morehead City and Charleston, SC.

Also known as the NEXRAD, or Next Generation Radar, the WSR-88D provided additional capabilities over those it was replacing. One such capability is the ability to use the Doppler principle to measure speed of meteorological targets towards or away from the radar. This allows for the detection of rotations within storm systems. Additionally, the NEXRAD automatically scans several

All October, NWS Wilmington (NC) has been commemorating the KLTX WSR-88D for its 25th Anniversary. This post shows the radar during the 1/25/2000 snowstorm. Just one of many significant events during the radar's lifetime.

Continued on page 2....





elevations, providing better volumetric detail of the atmosphere. On earlier radars, operators had to manually point the radar to a desired elevation.

The RDA, or Radar Data Acquisition, is the part we call the “radar” that includes the transmitter, receiver, and antenna. It is in Shallotte, but it sends the radar data to our office in Wilmington, to the RPG, or Radar Product Generator. The RPG takes the base reflectivity and velocity data from the RDA and processes it into more detailed products for the forecasters. Think of this as the communication hub for the radar data.



The Klystron, the main power amplifier of the NEXRAD transmitter.

Many changes have been made to the radar since it was installed. Most of these changes involve improvements to the computer systems that control the radar systems. In the early 2000s, the original computer system in the RPG was upgraded to a more simple system, known as Open RPG. In the mid 2000s, the RDA went through a similar upgrade, known as Open RDA (ORDA). In addition to the upgraded computer system, ORDA simplified the radar receiver. This would lead the way for Dual Polarization.



The RF Pallet, part of the Dual Polarization upgrade. This component splits the main transmitted pulse into horizontal and vertical components.

In 2012, our radar was upgraded to Dual Polarization (equipment shown in the image on the left and at the bottom right of this page). This upgrade enabled the radar to detect the size of meteorological targets, allowing them to differentiate between rain, hail, and other types of targets. This has led to improved skill of forecasters across the country allowing us to better warn on potentially dangerous thunderstorms.

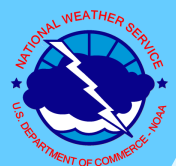
This upgrade involved more changes to the receiver, moving most of the components from inside a cabinet inside the shelter to the back of the moving antenna.

Research using dual-pol products continues today and with advances in network speed, forecasters can view the entire structure of a thunderstorm in seconds.



The AME, or Aerial Mounted Equipment, processes the dual polarization returns.

The Wilmington Wave
National Weather Service, Wilmington, NC



Continued on page 4....



Currently, the NEXRAD program is going through a Service Life Extension Program, or SLEP. SLEP involves multiple phases of upgrades and changes to the radar system.

As part of SLEP, our radar's processor was upgraded 2 years ago. Earlier this year, improvements were made to the transmitter, including upgrading the internal and external wiring. Future phases will include refurbishment to the building and replacing the pedestal.

The pedestal is the part that holds the dish and houses the motors and gears that move it (seen on the right and bottom left).



A view of the NEXRAD Pedestal, with the RF Pallet on the right and AME on the left.



Motor attached to the gearbox. This is inside the pedestal.

When the pedestal is replaced, contractors will remove our RADOME by lifting it with a crane, remove our pedestal, and replace it with one that has refurbished components.

The purpose of SLEP is to allow the NEXRAD to continue operating for the next 20 years. So even as radars get older, their components are continually refurbished and updated. This ensures that forecasters and Electronics Technicians have the most up-to-date technology available to them. These upgrades and improvements will continue to save lives for the remainder of KLTIX's lifetime.



The Receiver cabinet. Originally this cabinet was full of components, and even had another inside door to hold them. Now, it essentially holds the RF Generator (the big silver box in the lower center) which generates the pulse that is amplified by the Transmitter, and the IF Digitizer (Gold box horizontally mounted in the center), which digitizes the processed returns and sends them to the processor.

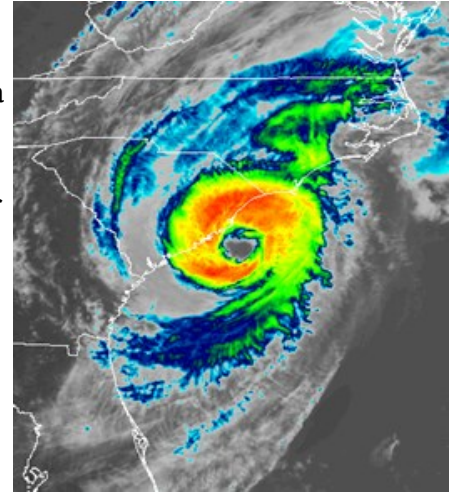
The Wilmington Wave
National Weather Service, Wilmington, NC



Hurricane Dorian

By: Tim Armstrong

Dorian was the strongest storm of the 2019 Atlantic Hurricane Season. As a category five hurricane, Dorian devastated Abaco and Grand Bahama Islands during the first few days of September, killing at least 65 people and damaging over seven billion dollars of property and infrastructure. After weakening significantly, Dorian turned north toward the United States and brought tornadoes, heavy rainfall, and storm surge flooding to coastal South and North Carolina on September 5-6.



Infrared satellite image of Hurricane Dorian approaching the Carolina coast on September 5, 2019

Dorian's eye missed the tip of Cape Fear by about thirty miles, but this was still close enough for the storm to drop 12 to 15 inches of rain from Georgetown through Pawley's Island to Myrtle Beach, SC. Rainfall in the Wilmington area ranged from 10 to 13 inches. Flash flooding developed across many of the coastal counties.

Fortunately only two weather stations on land recorded hurricane-force wind gusts, both near Fort Fisher in southern New Hanover County, NC. Storm surge flooding was worst from Murrells Inlet south into Georgetown where the strongest onshore



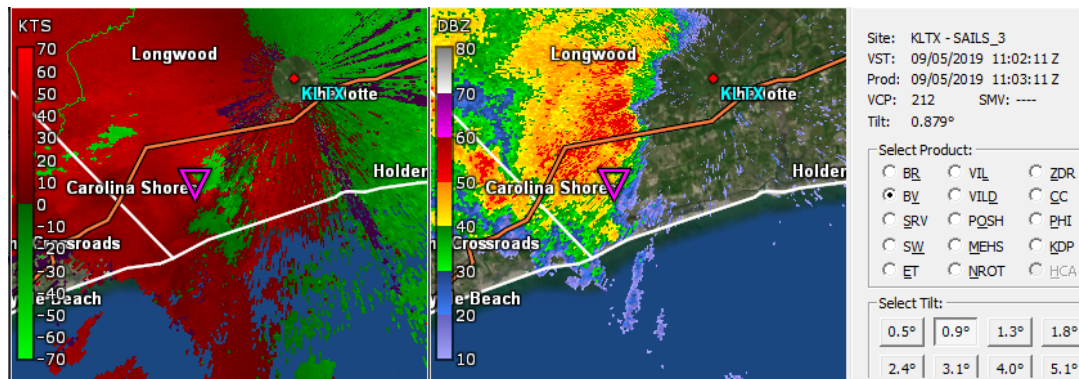
Rainfall Amounts (inches)		Peak Wind Gusts	
6 miles NE Pawley's Island, SC	15.21	Federal Point, NC	75 mph
Litchfield by the Sea, SC	13.44	Southport, NC	70 mph
Georgetown, SC	13.38	Surf City Pier, NC	70 mph
7.3 miles NE Wilmington, NC	13.07	Murrells Inlet, SC	64 mph
North Myrtle Beach, SC	10.74	Caswell Beach, NC	61 mph
Wilmington, NC	10.05	North Myrtle Beach, SC	61 mph
10 miles NE Conway, SC	9.96	Kure Beach, NC	60 mph
Little River, SC	9.66	Wilmington, NC	56 mph
1.7 miles NW Sunset Beach	9.55	Georgetown, SC	55 mph
1.2 miles NNW Calabash, NC	8.78	Topsail Beach, NC	53 mph
7.8 miles SW Bolivia, NC	7.56	Florence, SC	48 mph
4 miles SW Lake Waccamaw, NC	6.05	Lumberton, NC	48 mph

winds coincided with high tide. Sand dunes were damaged or destroyed on Pawley's Island and Litchfield Beach.

One of Dorian's most significant impacts on the Carolinas was from tornadoes. A total of 19 confirmed tornado touchdowns occurred across South and North Carolina during the storm, affecting areas as far south as Socastee, SC and as far north as Vanceboro, NC.

For tornadoes to occur within a tropical storm or hurricane, several ingredients must come together. Wind shear, moisture, and warm unstable air must first exist in the right combination. Wind shear is a change in wind speed and direction with increasing height above the ground and typically is strongest in the northeastern quadrant of a tropical storm or hurricane. If shower or thunderstorm cells develop where wind shear is favorable and if the air is humid and unstable enough, a series of tornadoes can be the result. These conditions came together during Hurricanes Dorian and Florence where dozens of tornadoes occurred. In contrast, Hurricane Matthew in 2017 produced only one tornado in the Carolinas as the air was cooler and not nearly as unstable.

One tornado associated with Hurricane Dorian was particularly powerful and struck the Carolina Shores community near Calabash, NC early in the morning of September 5. Analysis of the damage by NWS meteorologists revealed wind speeds likely reached 120 mph, snapping hundreds of trees and damaging over a dozen homes along a four-mile long damage path. One person was injured in The Farms at Brunswick subdivision. This EF2 tornado began as a strong waterspout that moved onshore at Tubbs Inlet at 6:58 AM. The tornado cut a path almost 10 miles long through western Brunswick County, NC, at one point growing in size to 200 yards in width as indicated by the observed damage path. The tornado finally dissipated in swampland near the Waccamaw River around 7:17 AM.



NWS Doppler radar images from 7:02 a.m. on September 5, 2019 show the thunderstorm that produced a tornado in the Carolina Shores community near Calabash, NC. The red-green image on the left shows wind velocity; the green-yellow-red image on the right shows precipitation intensity. The triangle in both images shows the radar-indicated location of the tornado.



NWS meteorologists conducting a storm survey took this photo of damage to homes in Carolina Shores, Brunswick County, NC, after the early morning tornado of September 5, 2019.

The Wilmington Wave
National Weather Service, Wilmington, NC

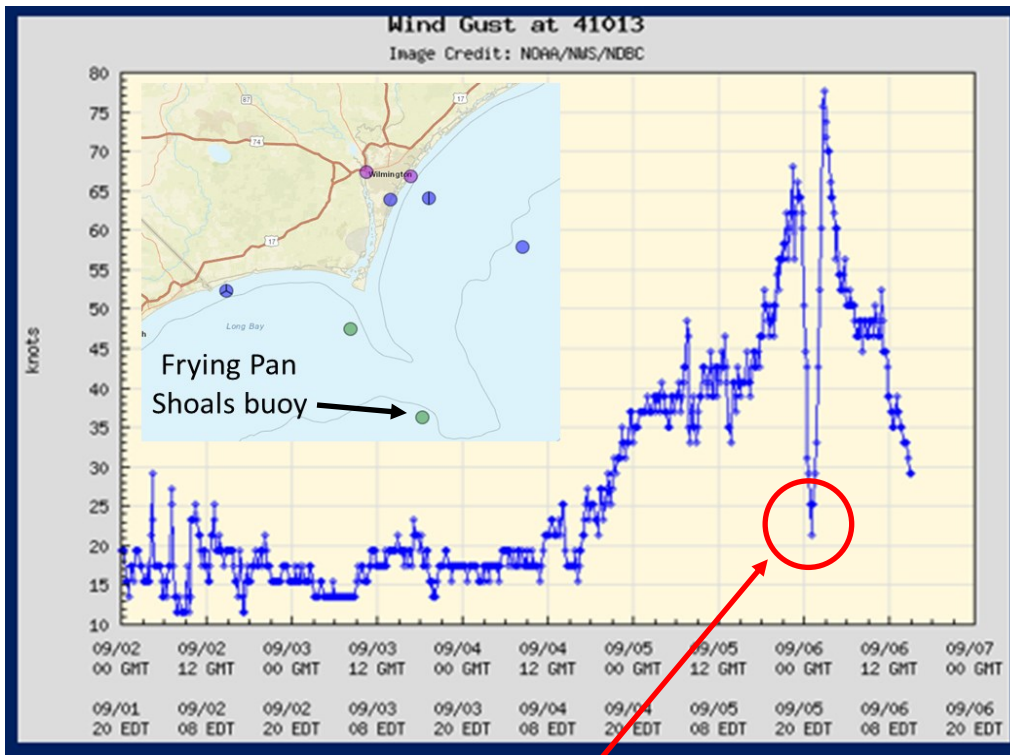
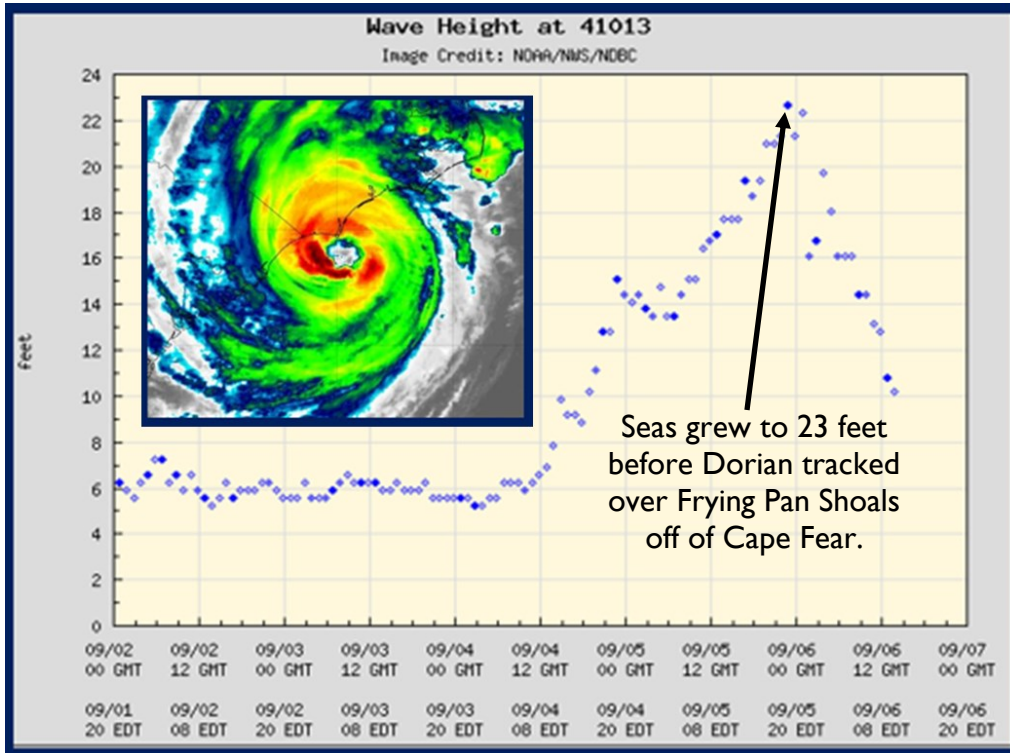
**For additional information
on Hurricane Dorian's impacts
on the Carolinas:**

**Visit
[Weather.gov/ILM/Dorian](https://www.weather.gov/ILM/Dorian)**



Dorian Made Waves

By: Michael Colby

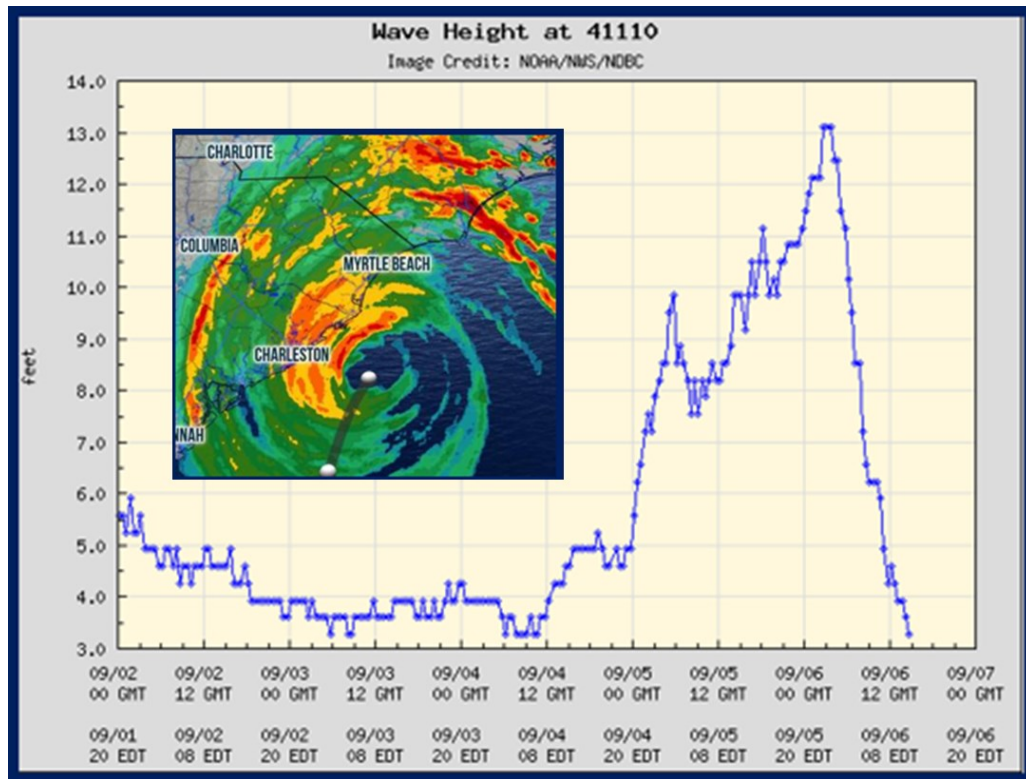


Look what happened to wind gusts as the eye of Dorian passed overhead of the buoy, winds took a dip, then later, WHAM!

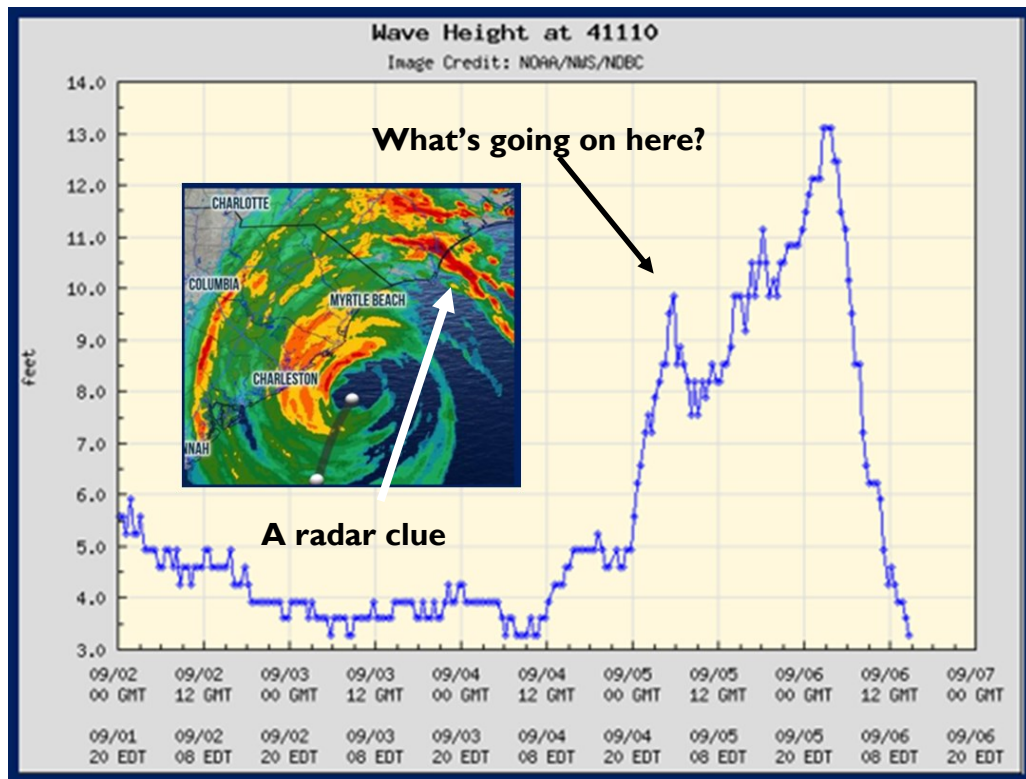
Continued on page 10....

The Wilmington Wave
National Weather Service, Wilmington, NC

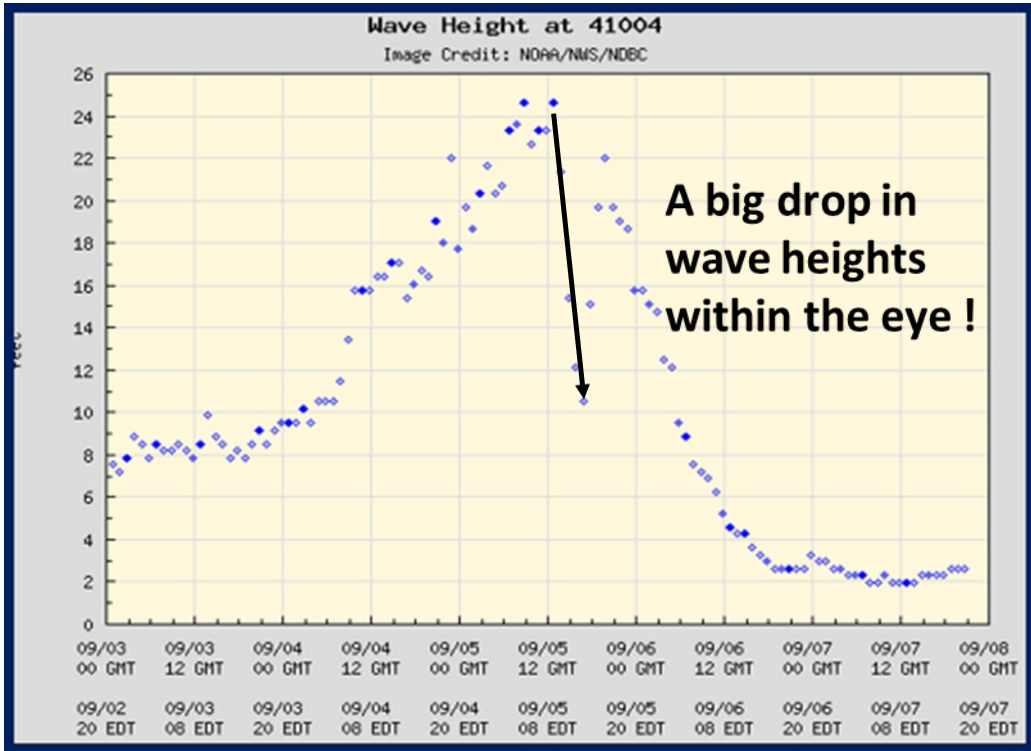




Wave heights 5 miles offshore of Masonboro Island, while not as large as well offshore, peaked at just over 13 feet.

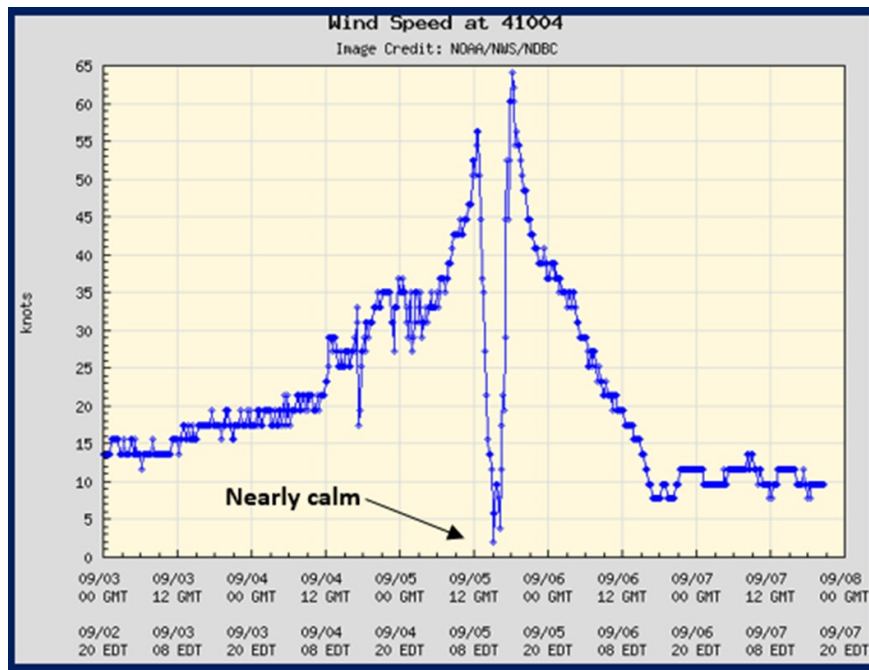


Did the clue help? A peak in wave height before the main peak, was caused by gusty winds in strong outer bands, well northeast of the eye.



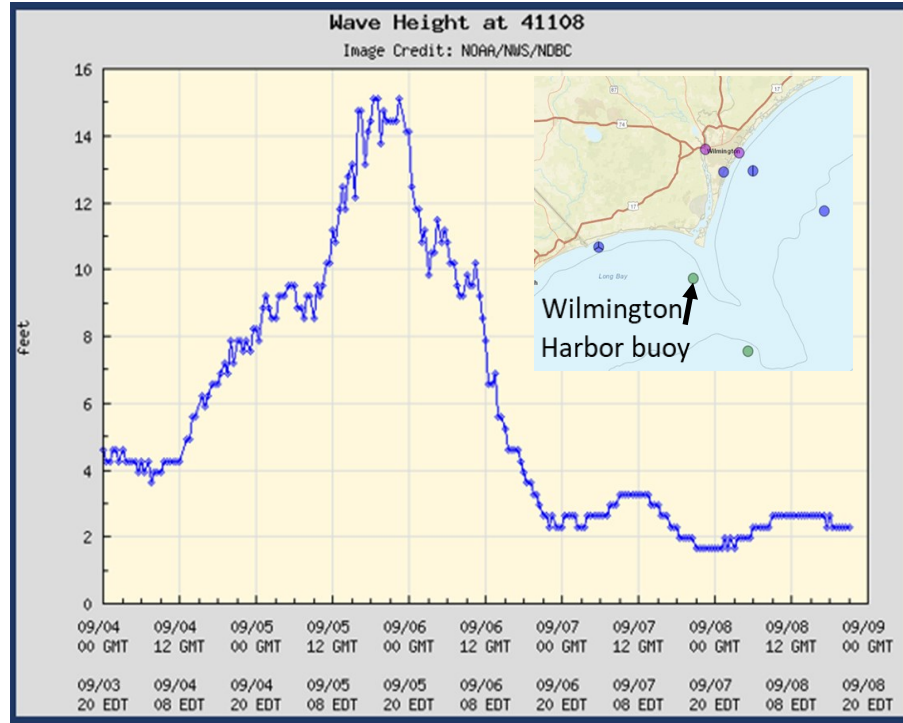
With the eye overhead, winds almost calm, seas dropped from a raging 25 feet, to about 10 feet of smooth, glassy swell waves.

A more dramatic example of Dorian's eye passing over a buoy. The Edisto buoy offshore and southeast of Charleston SC. Winds almost went completely still, as Hurricane Dorian passed directly overhead.

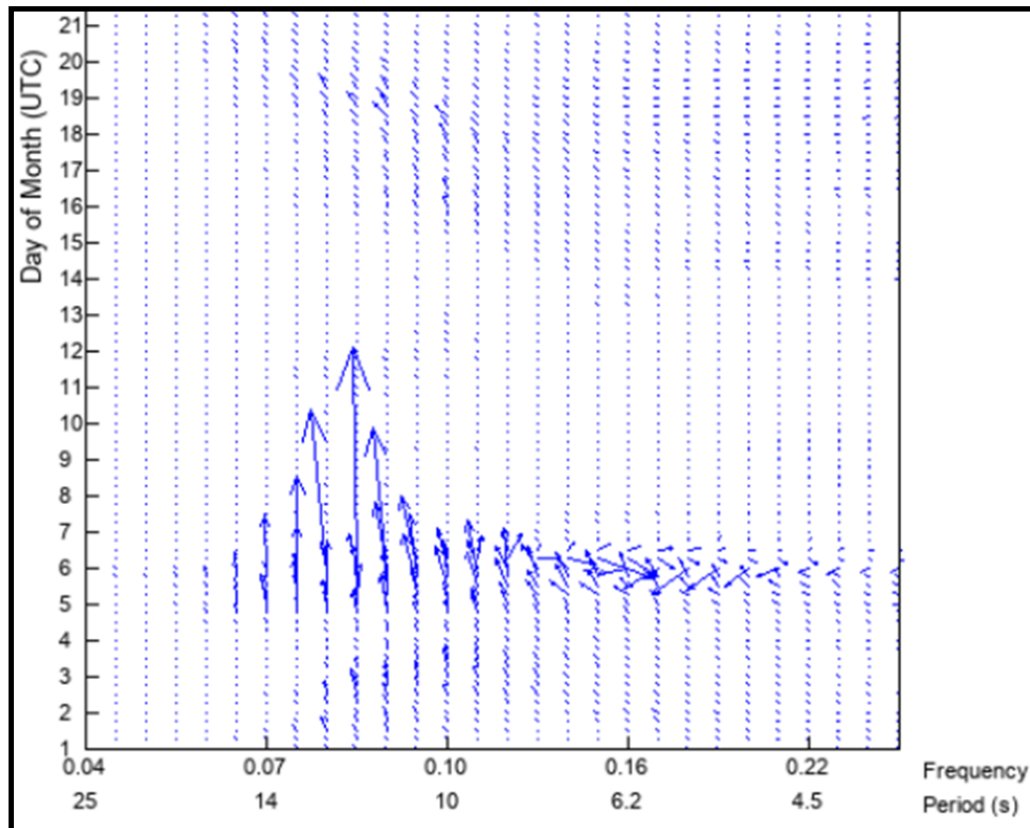


The Wilmington Wave
National Weather Service, Wilmington, NC





The Wilmington Harbor buoy reached over **15 feet**, several feet higher than the Masonboro buoy off the New Hanover coast. This is partly due to **direct exposure** of incoming south waves, as seen in wave direction plots below. Roughly 12-13 seconds elapsed between each large wave.



2019 Surf Season Summary

By: Victoria Oliva

The 2019 beach season for our area began on April 5th and ended on October 31st. Prolonged above normal temperatures led to a hot September, while several off-shore tropical systems created rough surf at our beaches. Staff at Wilmington, NC NWS continues to work with local lifeguards on a daily basis to verify and improve our surf forecasts.

Due to either a strong tropical system, or a persistent east-southeasterly swell, we have had several stretches of elevated rip current risk days, particularly since late July. From late July to mid-August, a moderate rip risk was in place for most of our beaches. This was due to persistent southeast swell from combination of high pressure to our north and South Atlantic non-tropical storms. This stretch also included the highest rescue day at Wrightsville Beach, with more than 40 people rescued by Ocean Rescue.



From late August through very early October, Hurricanes Dorian, Humberto, Jerry and Lorenzo all led to stretches of moderate or high rip risk days for our beaches, with only a handful of low risk days during that stretch. In total, roughly **half** of the 2019 beach season for east and south facing beaches was moderate or high risk rip days (Pender, New Hanover, most of Brunswick, and Georgetown) while **one-third** of the season for southeast facing beaches was moderate or high rip risk days (Horry and beaches west of Ocean Isle in Brunswick County).

Unfortunately, 2019 has also had many surf zone fatalities. A total of 85 surf zone fatalities has occurred nationally in 2019 as of October 3rd, with five of those occurring at local beaches within our area. National Weather Service continues to work with partners across the country on beach safety awareness to continue to reduce these numbers. Almost 400 rescues were reported to our office from our lifeguard partners, highlighting the importance of swimming near a lifeguard if at all possible.

Our office is continually working to improve our products and provide the best service we can to the public. On August 21st, we introduced an Outlook section to our SRF product, highlighting hazards and forecasted rip current risk for several days out. This section was the first step in our plan to provide the best forecast we can using our surf forecast products. Be on the lookout for a **new look** to our SRF product next year, as the NWS rolls out a national format to make it easier to interpret the forecast regardless of where you are in the country.



See you next Spring for our 2020 beach season!



The Wilmington Wave
National Weather Service, Wilmington, NC



Winter Weather Tips

- ❄ While southeast NC and northeast SC have relatively mild winters, we still have extreme weather events that may affect our area such as ice storms, extreme long-duration cold snaps, and nor'easters that bring snow, rain, and wind. It is important to be ready for these events because it only takes one to cause loss of life and property.
- ❄ In preparation for a winter weather event, keep in mind that the primary concern will be the loss of heat, power outages, and shortage of supplies if storm or proceeding conditions persist for more than a couple of days.
- ❄ Before winter weather strikes, be sure to take necessary precautions such as maintaining, cleaning, and annually inspecting chimneys and other heating equipment, and making sure your vehicle is prepared by having a full gas tank and inspecting the antifreeze levels, brakes, battery, and more!

❄ Be sure to check out our new and improved **Winter Weather webpage** at www.weather.gov/ilm/winter! Page includes current snow and ice forecasts, such as probabilistic snowfall, as well as Weather Type forecasts for the next 5 days, our latest weather briefing, local winter climatology, and winter weather safety tips.

The Wilmington Wave
National Weather Service, Wilmington, NC



Probabilistic Snowfall Forecasts	Ice Accumulation Forecasts	Other Snow/Ice Information	Long-Range Forecast
Weather Type Forecast	Latest Weather Briefing	Local Winter Climatology	Winter Weather Safety

Latest Weather Briefing

[Latest Briefing from Wilmington, NC NWS](#)

Weekly Weather Briefing

Disaster Kit Preparation

For Home/Work

- Flashlight and extra batteries
- Battery-powered NOAA Weather Radio
- Extra food and water (one gallon of water per person, per day)
- Prescription medicines
- Cash and a credit card, emergency phone numbers
- Important documents
- Blankets and change of clothing per person
- First aid supplies
- Fire extinguisher/smoke alarm/carbon monoxide detector
- Heating fuel
- Emergency heat source

For Vehicle

- Mobile phone, charger, batteries
- Windshield scraper or de-icing spray
- Flashlight with extra batteries
- Battery powered radio
- Compass and road maps
- Water and snack food
- Matches
- Extra hats, socks, mittens, and clothing
- First aid kit with pocket knife
- Necessary medications
- Blanket(s) & sleeping bags
- Tow chain and/or rope
- Jumper cables
- Emergency flares or Fluorescent distress flag

For additional information, visit www.ready.gov/winter-weather



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.

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.



The Wilmington Wave
National Weather Service, Wilmington, NC





EveryThing

With: Steve Solana (ET)

What does ET stand for and what exactly do you do?

ET stands for EveryThing :). It actually stands for Electronics Technician. As an ET we maintain a variety of equipment. The Radar, ASOS's, and NWR's are the main pieces of equipment we maintain.

Most people know about the Radar, it shows you what weather is out there by emitting a Radio Frequency that bounces off small objects (rain, sleet, snow, debris) and that signal is then reflected back to the antenna. The received RF can then be processed and distributed to our partners (Universities, News Stations, Accuweather, etc.) and used by our meteorologists to create forecasts and issue warnings.

The Automated Surface Observing System (ASOS) collects local weather data (temperature, visibility, pressure, etc.). It is located at different airport sites and is used by the FAA for flight safety and by the NWS for forecasts, climatology, and local observations for the public.

The NOAA Weather Radio's (NWR) are an early warning radio system used to disseminate localized weather information and to broadcast warnings and watches that will set off weather radios for severe weather.

While these are the main pieces of equipment that we maintain, they are not the only things we work on. We also maintain the communications to all the equipment, maintain the office LAN and PC's, perform generator maintenance, and fix facility issues that pop up.



The Wilmington Automated Surface Observation Station (ASOS) which measures wind, weather, visibility, cloud height, temperature, rainfall, and many other meteorological variables!

Where does the radar data go when you send it, who uses it and what kind of impacts would not having this data cause?

The data from the radar is sent back to the local WFO servers where it is then disseminated to, essentially the world. News stations take the data and run it through their own software to give the public different looks and their own customized "Doppler 5000" look, Universities use the data for their own studies, Apps use the data to give their users. etc. Without this data, you wouldn't have radar coverage for the area covering almost 150m radius and it would severely impact the ability of the local WFO to issue warnings and weather forecasts.

How many ETs are there in our office compared to how many different pieces of equipment you maintain?

There are 2 ETs in our office. We maintain 1 Radar, 4 ASOS sites, 5 NWR sites, and the most of the technology within the local forecast office. We are fortunate to only have a few pieces of equipment to maintain at this office. There are some offices in our region that maintain twice as many ASOS and NWR sites as well as an Upper Air (balloon launch) site and they do all this with the same amount of manpower.

As an estimate, how many miles do you drive in a year to maintain equipment at different sites?

Most of our sites are located 1-2.5 hrs away and the problems and issues with equipment vary throughout the year, but I would say on average we probably drive close to 18,000 miles a year (that's the equivalent of a round-trip to Sydney, Australia).

What are the most challenging pieces of equipment to maintain and why?

I would say the Radar is the most challenging piece of equipment we work on. It is by far the largest and most complex system we have to maintain. There are so many different components to the system that could break or malfunction. Sometimes it's software related, other times it may be a mechanical motor used to turn the dish, you just never know what could break on the system. Fortunately, it has a good alarm system that help us narrow down the problem pretty quickly, but every now and then it will throw something at you that you haven't seen before and it may take a little time to get it back up. The other reason this is the most challenging piece of equipment is because of the time constraints we are usually on to get it back up and spinning. The data it provides is paramount to saving lives during a severe weather event and we know the meteorologists and public rely on it heavily.

Continued on page 18...

The Wilmington Wave
National Weather Service, Wilmington, NC





How do you envision your job changing as technology progresses?

I see a shift into more IT related responsibilities. It has already been shifting that way for awhile. As these systems are upgraded and their service life is extended, old technology is slowly being faded out. This is awesome because of the potential for improved capabilities the new technology brings, however, new technology also brings with it added procedures and policies that must be followed for security reasons.

How did you get where you are (path of education and experience) and what would you tell someone if they wanted to pursue this career?

I started out as a young boy..... dreaming about working on Radars and other Electronics Equipment.....and.....yeah I can't keep that up, :). The path to where I am today, like so many other ETs, started in the military. I enlisted in the Marine Corps and had planned on working as an Aviation Electronics Technician. That is what my original training was for. I was selected from my graduating class to stay for a follow on school and become a Radar Technician for Air Traffic Control (ATC) Radar. All of my radar/electronics training and experience came from those schools and hands on at my duty station MCAS Yuma. I finished my enlistment and was able to land an ET job working for the Air Force DOD as a civilian on their ATC radar system. I then transitioned to the NWS working on weather radar. I have had to get certified on almost every system I have worked on. There was a lot of on-the-job training, but the majority of certifications were taken through formal training provided by the Marine Corps or by the department I worked for (DOD, NWS). If someone wanted to pursue a career as an ET for the NWS or another agency, I would say you almost have to start out in the military in a career field that involves Electronics or Communications. I do not know any ET who is not a veteran.

What is the most dangerous piece of equipment that you maintain?

I would say the most dangerous piece of equipment we work on would be the transmitter in the radar, especially when we have to work in the modulator cabinet or backplane. There is extremely high voltage there. There are specific procedures that must be followed to ensure we de-energize the system so we don't get shocked while working on it. I'm not talking about a little *zap!* and you shake it off. The amount of voltage present in this cabinet is the **ZAP!** and then you're dead or severely injured kind of shock.

What about this job is unique and how is it important to the Weather Service?

Unlike many jobs, this isn't a 9-5 go home and forget about work. Equipment doesn't care what time of day it is or what the weather is like when it breaks. It takes sacrifice, communication and teamwork to ensure that the equipment and things like communications from the office to the public stay operational. I am blessed to work with a great team here who take pride in taking care of each other and keeping the equipment operational.

Weather Ready Nation

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. 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 on how to become a WRN Ambassador, visit:

<http://www.weather.gov/wrn/about>



The Wilmington Wave
National Weather Service, Wilmington, NC



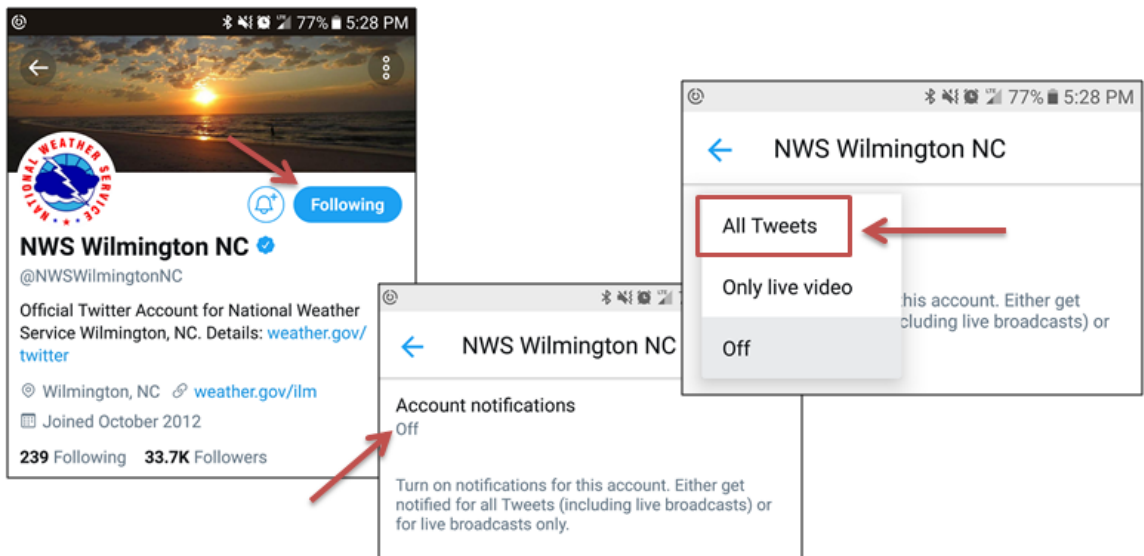
Social Media Notifications

Whether it's during active weather, storms in your area, or you are just interested in information from the National Weather Service, you can turn on social media notifications from your local NWS office to stay notified of ongoing weather in your area. For Twitter, you can turn on mobile notifications alerting you of new tweets from your NWS office. For Facebook, you can choose to turn on Notifications for the NWS page that will send you a notification within Facebook for new posts, up to 5 a day.

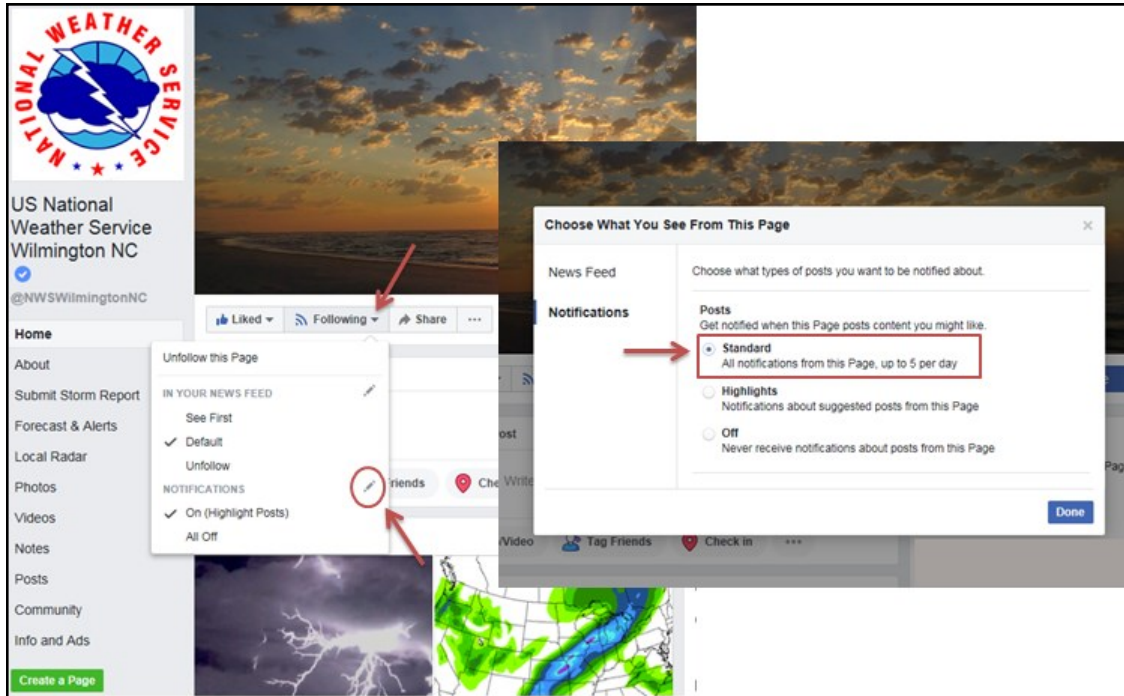
Twitter via Desktop



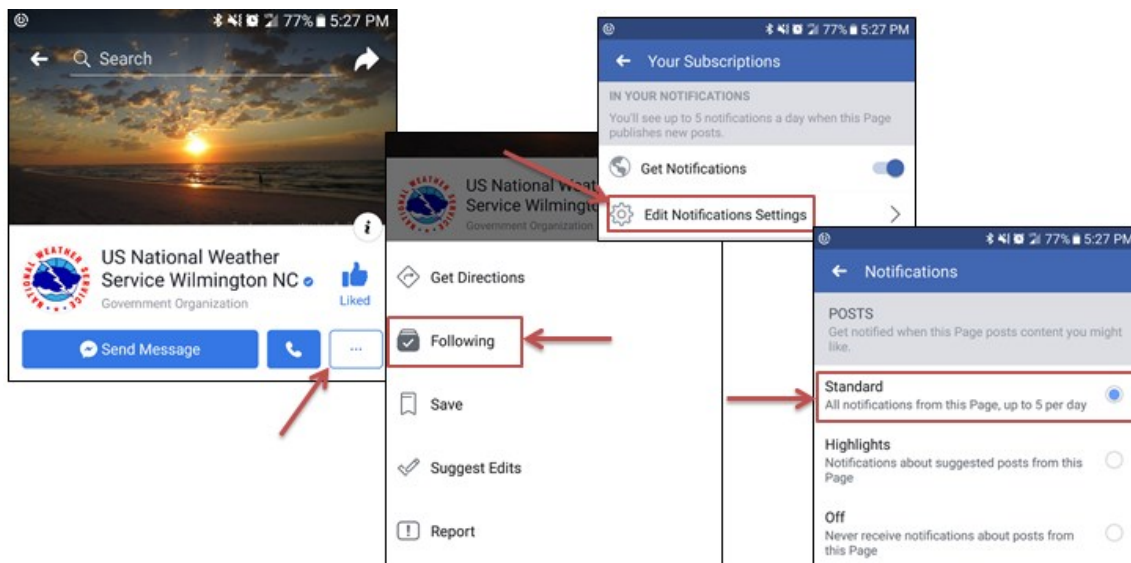
Twitter via Mobile



Facebook via Desktop



Facebook via Mobile



The Wilmington Wave
National Weather Service, Wilmington, NC





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



Follow Us on Social Media



[NWSWilmingtonNC](https://www.facebook.com/NWSWilmingtonNC)



[@NWSWilmingtonNC](https://twitter.com/NWSWilmingtonNC)

The Wilmington Wave
Volume IX, Issue II

Contributors:

Tim Armstrong

Michael Colby

Chris McDermott

Victoria Oliva

Steve Pfaff

Steve Solana

Editors:

Jordan Baker

Victoria Oliva

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

The Wilmington Wave
National Weather Service, Wilmington, NC

