MIAMI-SOUTH FLORIDA
National Weather Service
Forecast Office
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2016 South Florida Weather Year in Review

Stormy Winter and Big Hurricane Threat
Warmer Than Normal Once Again

December 30th, 2016: 2016 will go down as an active weather year across South Florida, as our region experienced not only severe weather and tornadoes early in the year, but a significant threat from a major hurricane in early October. In between and throughout most of the year, it was warmer than normal and precipitation amounts varied from wetter than normal across western areas of South Florida to drier than normal across a good part of the East coast metro areas.

2016 began with a very active severe weather period starting in mid-January and lasting into March. A series of storm systems affected the area, bringing severe thunderstorms, flooding and tornadoes. A total of 9 tornadoes were confirmed during this period, four of these being of EF-1 intensity (winds 86-110 mph) on the Enhanced Fujita Scale. Six severe weather days (days with multiple reports of flood, tornado, wind or hail events) occurred during this time frame. The strong El Niño pattern of last winter was a key contributor to the increased storminess and severe weather. January was the wettest on record at many South Florida locations and the South Florida Water Management District determined that the winter of 2015-2016 was the wettest on record for the general South Florida region since records began in 1932.

After this severe weather period, drier than normal conditions prevailed into the summer. The summer was dominated by high pressure aloft which led to abnormally dry conditions over eastern areas of South Florida. Meanwhile, interior and western areas were wetter than normal. The summer was also hotter than normal and resulted

in a tie for the hottest summer on record in West Palm Beach and among the top 10 hottest on record across the rest of South Florida.

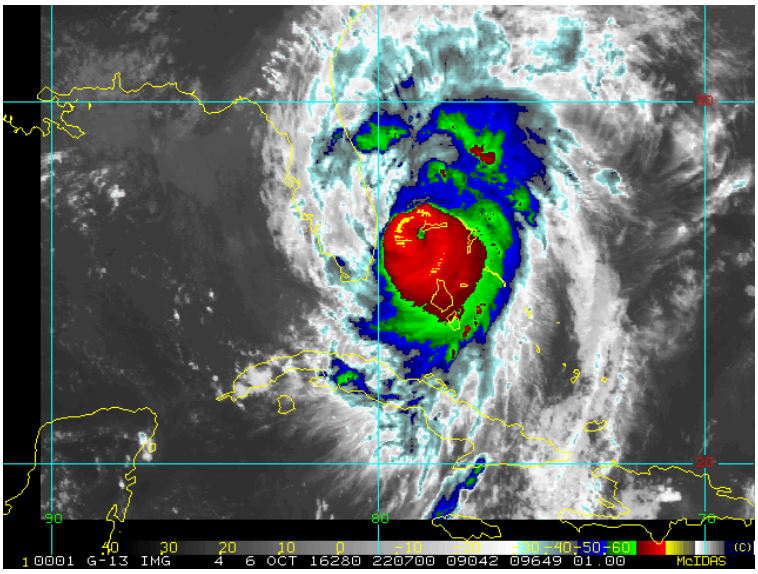
Hurricane season made its presence felt across South Florida in 2016. The first threat was from a tropical disturbance which eventually became Hurricane Hermine in the Gulf of Mexico during the end of August/beginning of September. South Florida escaped impacts from Hermine aside from enhanced rainfall and slightly elevated tides along parts of the Collier County coast, but the real threat came from Hurricane Matthew during the first week of October. Matthew, a major hurricane which reached Category 5 strength in the Caribbean Sea before striking parts of Haiti and Cuba, passed over the Bahama Islands and came close enough to South Florida to prompt hurricane and tropical storm warnings across the region. Although the core of Matthew remained just offshore with no hurricane impacts in South Florida, winds of tropical storm force were felt along the Southeast Florida coast and moderate beach erosion was observed.

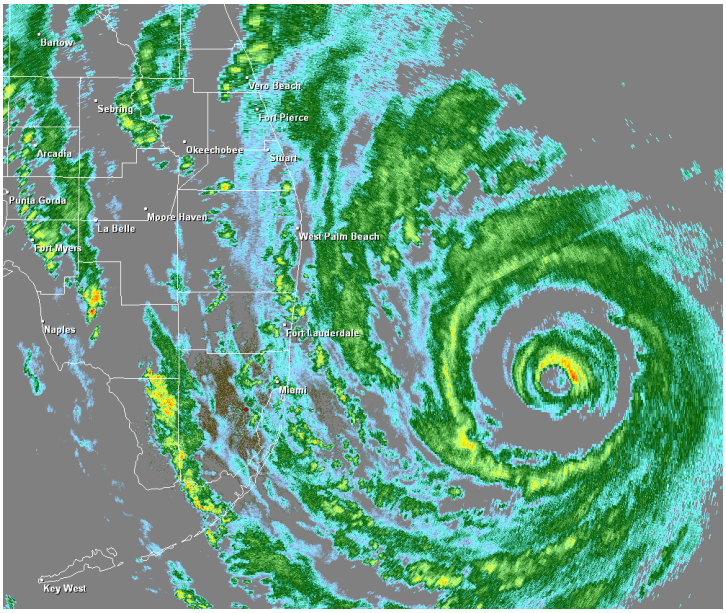
After a quiet and uneventful end of October and November, December returned to the warmer than normal pattern of much of the year and likely end up among the top 3 warmest Decembers on record.

Below is a listing of the top 5 south Florida weather stories for 2016, followed by a summary of rainfall, temperatures and hazardous weather.

#1 Weather Story of 2016

Hurricane Matthew Near-Miss: October 6th

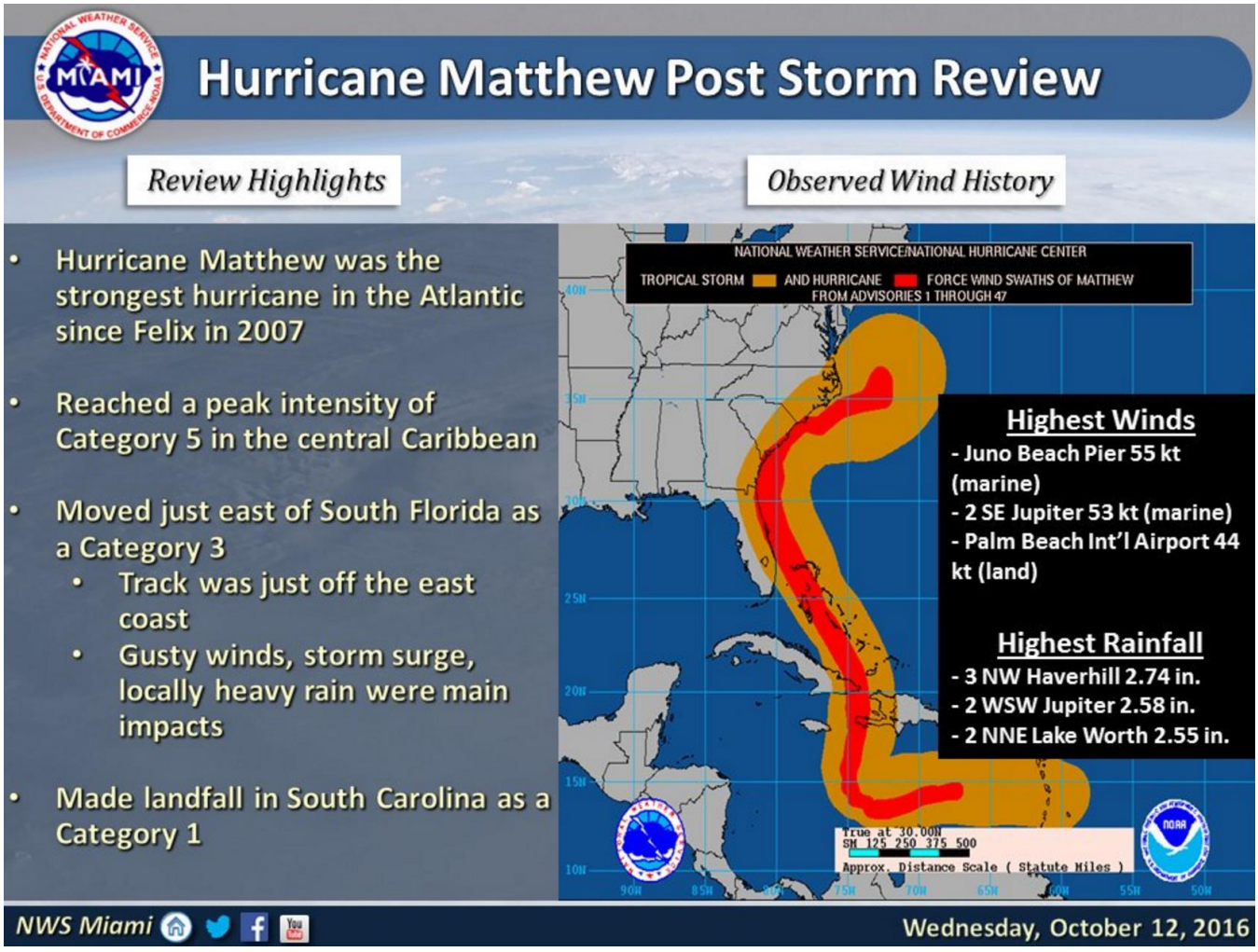




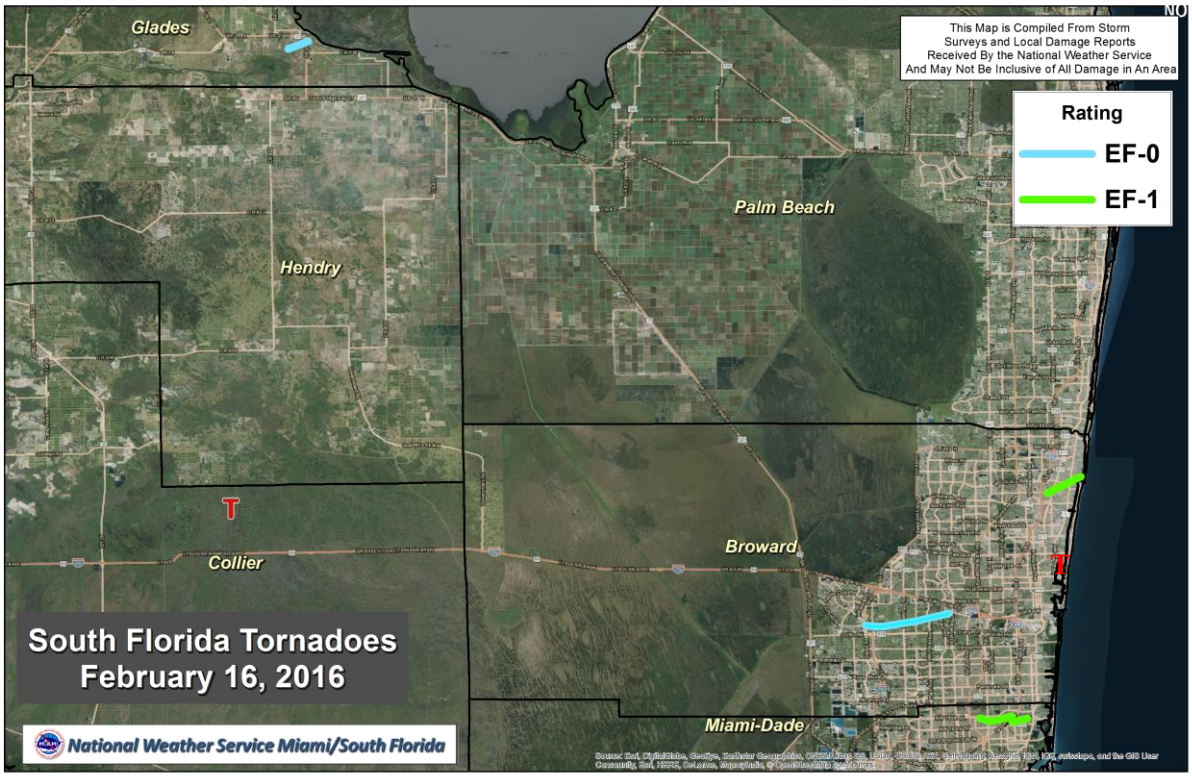
Hurricane Matthew was the biggest hurricane threat to South Florida since Hurricane Wilma in October 2005. Hurricane warnings were posted for Palm Beach and Broward counties, and Tropical Storm warnings were issued for the remainder of South Florida as Matthew moved across the southern Bahamas and the forecast track had the storm passing very close to South Florida. Fortunately for South Florida, hurricane force winds and other severe impacts remained just offshore. Sustained tropical storm force winds

over land were confined to eastern Palm Beach County and the immediate coast of Broward County.

Main impacts were: beach erosion and wind damage to trees and siding. Damage to beaches is estimated at near $20 million in Palm Beach County, nearly $2 million in Broward County and close to $1 million in Miami-Dade County. Nearly 100,000 customers lost power during the storm across the three-county area of SE Florida.



#2: February 16th Tornado Outbreak



January through March 2016 was a very active severe weather period across South Florida as a series of storm systems affected the area, bringing severe thunderstorms, flooding and tornadoes. A total of 9 tornadoes were confirmed during this period, four of these being of EF-1 intensity (winds 86-110 mph) on the Enhanced Fujita Scale. Six severe weather days (days with multiple reports of flood, tornado, wind or hail events) occurred during this time frame. The strong El Niño pattern of last winter was a key contributor to the increased storminess and severe weather.

One of these severe weather events was the tornado outbreak of February 16th. A strong squall line developed ahead of a cold front over the eastern Gulf of Mexico on February 15th. The squall line intensified as it moved across the warm waters of the loop current in the eastern Gulf. Strong low level rotation and an unstable environment were in place across South Florida ahead of this line. A Tornado Watch was issued at 2 am EST on February 16th. Another squall line developed near the Southwest Florida coast ahead of the first line and moved onshore just after 3 am EST, continued to move eastward

across the southern Florida peninsula. The original squall line moved into the west coast after 5 am EST, and merged with the first line near the southeast Florida coast just after daybreak.

Numerous severe storms developed as the line crossed the peninsula, with many exhibiting tornadic signatures. Small hail and strong straight line winds were also reported as this line moved towards the east coast. The squall line pushed offshore around 11 am EST.

A total of 6 tornadoes were confirmed across South Florida, including two EF-1 tornadoes (Pompano Beach and Moore Haven) and four EF-0 tornadoes (Miami Gardens/Ives Estates, Davie, eastern Collier County, and Fort Lauderdale Beach). The Pompano Beach EF-1 caused approximately $160,000 in damage. Additional wind damage was reported in Hollywood (where a woman was injured by a falling tree), Pembroke Pines, Miramar, West Palm Beach and Belle Meade (Collier County)

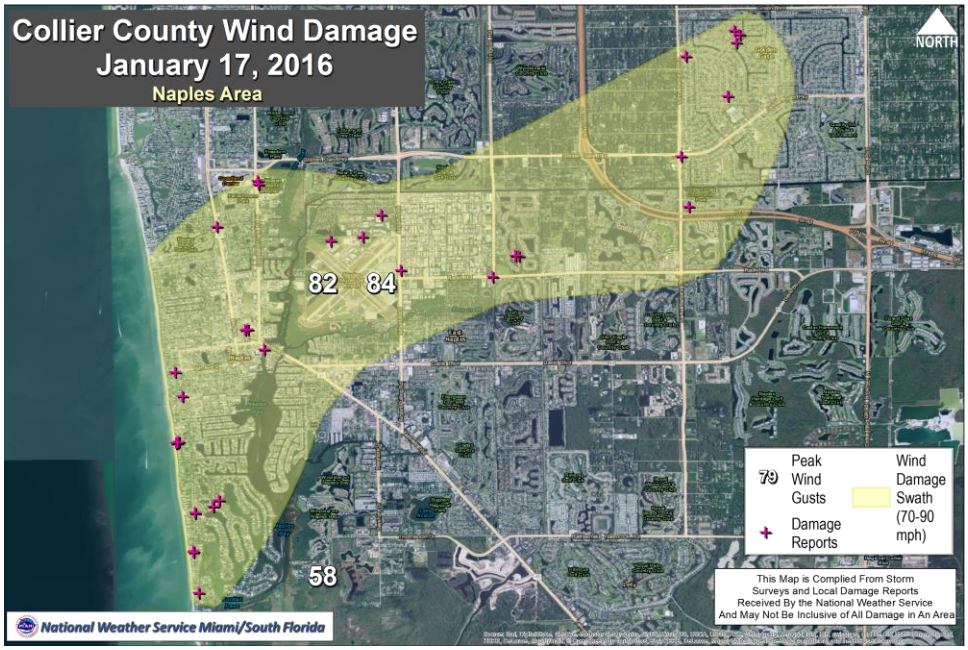
Pompano Beach Damage

Moore Haven Damage

Davie Damage

NE Miami-Dade/Ives Estates Damage

#3: Severe Thunderstorms and Meteotsunami in Naples: January 17th

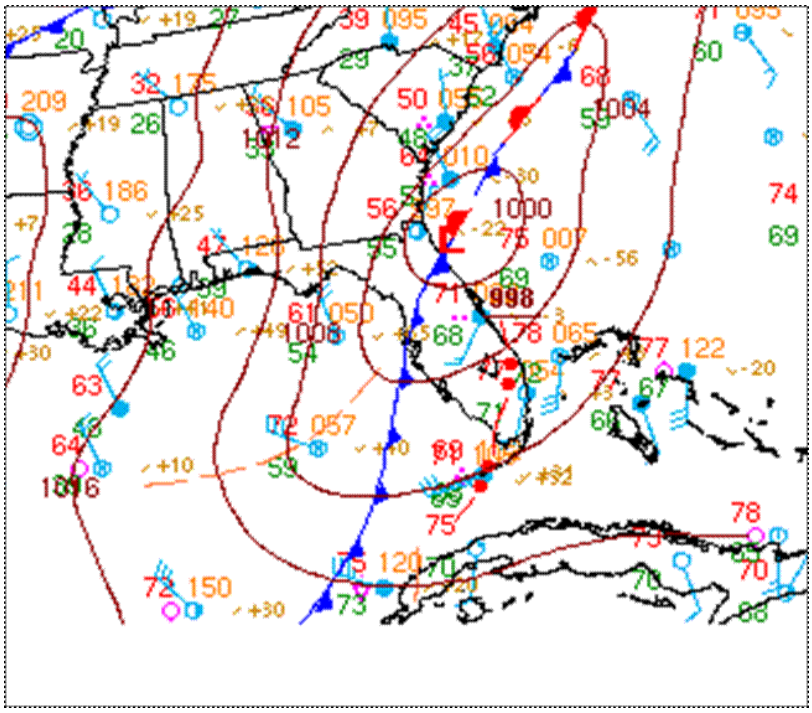


A low pressure area developed over the Gulf of Mexico on January 16th and moved across Central Florida on the 17th. A strong squall line developed over the Gulf of Mexico during the overnight hours ahead of the cold front, and rapidly moved onshore the Collier County coast just before daybreak on the 17th.

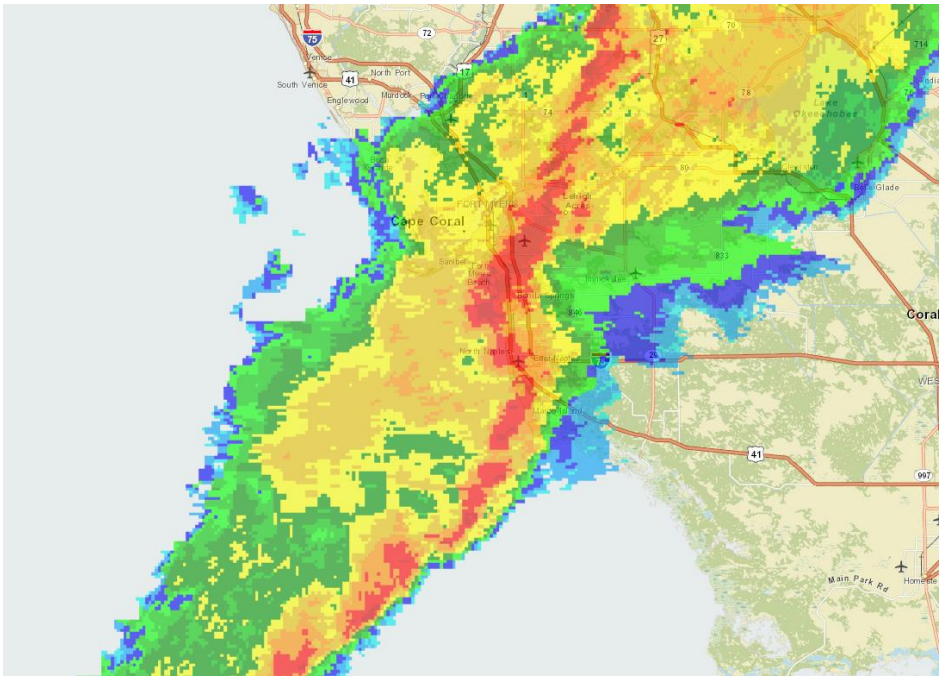
The squall line caused a large area of severe wind gusts with peak winds of 70 to 90 mph. A measured wind gust of 84 mph was recorded at Naples Municipal Airport at 525 AM EST. A wind gust of 79 mph was measured at the Seminole Indian Reservation in Immokalee at 551 AM EST. Damage was observed across a large swath of Collier County, with the strongest winds generally occurring across Naples where the line made landfall.

The damage primarily consisted of many downed trees and power lines, with minor structural damage noted in a couple of areas.

The squall line also caused what's known as a "meteotsunami", a tsunami-like wave of meteorological origin caused by traveling air pressure disturbances often associated with squall lines. Data from the NOAA tide gauge at Naples Pier recorded an increase in the water level of 3-5 feet shortly after the passage of the squall line, resulting in flooding of areas near the beach. An estimated 1 foot of water inundated beachfront streets for a short time after the meteotsunami moved onshore.



Weather Map at 7 AM EST January 17th



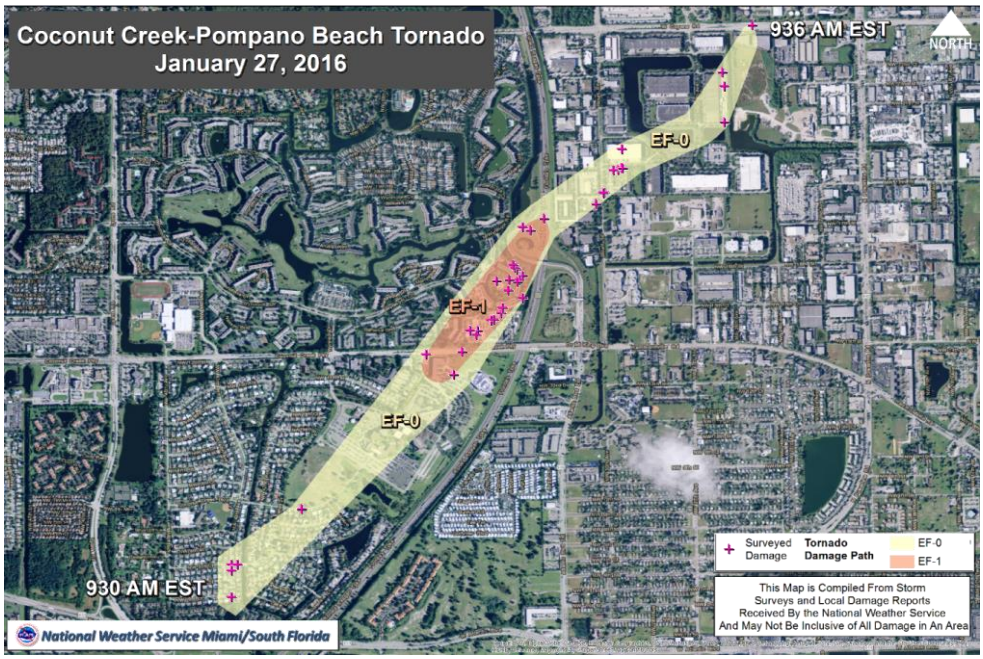
NEXRAD Doppler Radar Image at 525 AM EST showing squall line moving onshore

Naples Tree/Sign Damage

Naples Pier NOAA Tide Gauge Reading on January 17th

Beachfront home in Naples with water marks on building. Picture courtesy Jessie Settle

#4: EF-1 Tornado January 27th: Coconut Creek/Pompano Beach



An area of low pressure developed over the far southeastern Gulf of Mexico during the early morning hours of January 27th, 2016. This lifted a weak warm front through South Florida where it stalled out across Central Florida during the day on the 27th. The boundary remained stalled through the early afternoon hours on January 28th before a stronger upper level system lifted the area of low pressure across the state and brought a cold front through South Florida.

A line of severe storms moved across South Florida during the pre-dawn and early morning hours of the 27th, prompting the issuance of severe thunderstorm warnings and tornado warnings as it crossed the peninsula. A strong cyclic mesocyclone that moved onshore during the early morning hours tracked across the peninsula, where it re-intensified over north-central Broward County and produced an EF-1 tornado that moved across Coconut Creek and Pompano Beach.

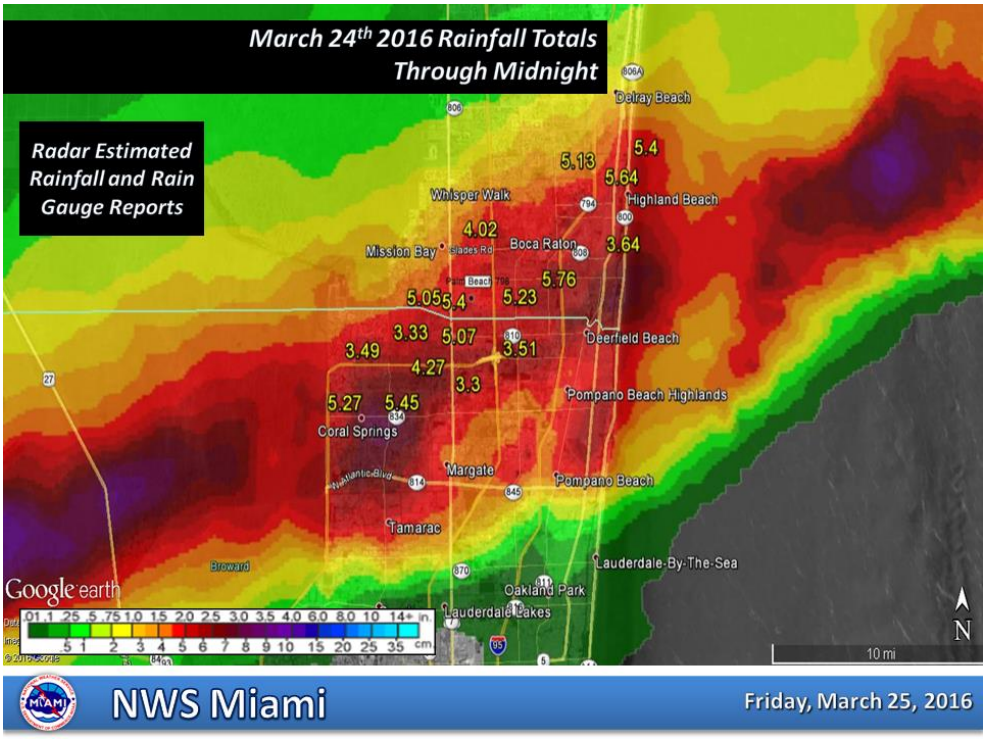
The tornado first touched down in Coconut Creek just southwest of the Broward College North Campus, snapping and uprooting several trees and damaging fences as it traveled to the northeast. The tornado crossed the campus, tossing several cars in the north parking lot near the Health Sciences Building. The tornado then crossed Coconut Creek Parkway just to the west of the Florida Turnpike, flipping a community bus on the road.

The driver of the bus sustained a minor injury. On the north side of the road, the tornado moved through the Wynmoor Village Condo Complex where the most significant damage was reported. Numerous trees were uprooted across the complex, with a few snapped in half and debarked, along with snapped light poles and damage to fences. Several mid-level condo buildings sustained moderate roof damage where roofing material and portions of concrete block were peeled off and thrown several yards, damaging numerous cars in the parking lot. The tornado then crossed the Florida's Turnpike near the Mile Marker 67 entrance and exit ramps. Several cars were tossed and damaged along the Turnpike, including one southbound travelling car that was flipped into the northbound lane, resulting in a minor injury. The tornado then weakened as it moved to the east side of the Turnpike and entered Pompano Beach, where large limbs were broken off trees, power lines knocked down, and smaller trees uprooted along Blount Road. Minor roof damage occurred to the North Homeless Assistance Center in this area. A tractor trailer was flipped at the Whole Foods Warehouse along NW 19th street and Blount Road, before the tornado travelled further northeast causing moderate tree damage along NW 25th Avenue. Total damage was estimated at $850,000.

The following day in association with the same weather system, a smaller tornado rated at EF-0 caused minor damage in the Delray Beach and Boynton Beach areas of Palm Beach County.

Tree and roof damage in Coconut Creek/Wynmoor Village

#5: (Tie) March 24th Flooding North Broward/South Palm Beach County (FAU campus flooding) and April 15th: Hail up to 2” in Palm Beach County



On March 24th, a strong upper level low pressure area moved across South Florida, combining with daytime heating to set off strong thunderstorms and flooding rains across parts of Broward and Palm Beach counties during the early evening hours. Wind gusts up to 55 mph downed trees across northern Broward County from Margate to Coconut Creek. Torrential rain from nearly stationary thunderstorms caused significant flooding across northern Broward County and southern Palm Beach County. Rainfall amounts were in the 5 to 6 inch range over the course of a few hours from Coral Springs to Boca Raton. Numerous cars stalled along local roadways and water damage was observed at several locations in Boca Raton, including the Town Center and Florida Atlantic University.

Large hail isn’t too common in South Florida, but on the afternoon of April 15th numerous reports of hail between 1 and 2 inches in diameter (ping-pong ball to slightly larger than golf balls) were received from Palm Beach County, mainly from Delray Beach north to Hypoluxo. A strong upper level low pressure system interacted with a stationary front across the Florida peninsula to trigger these severe thunderstorms.

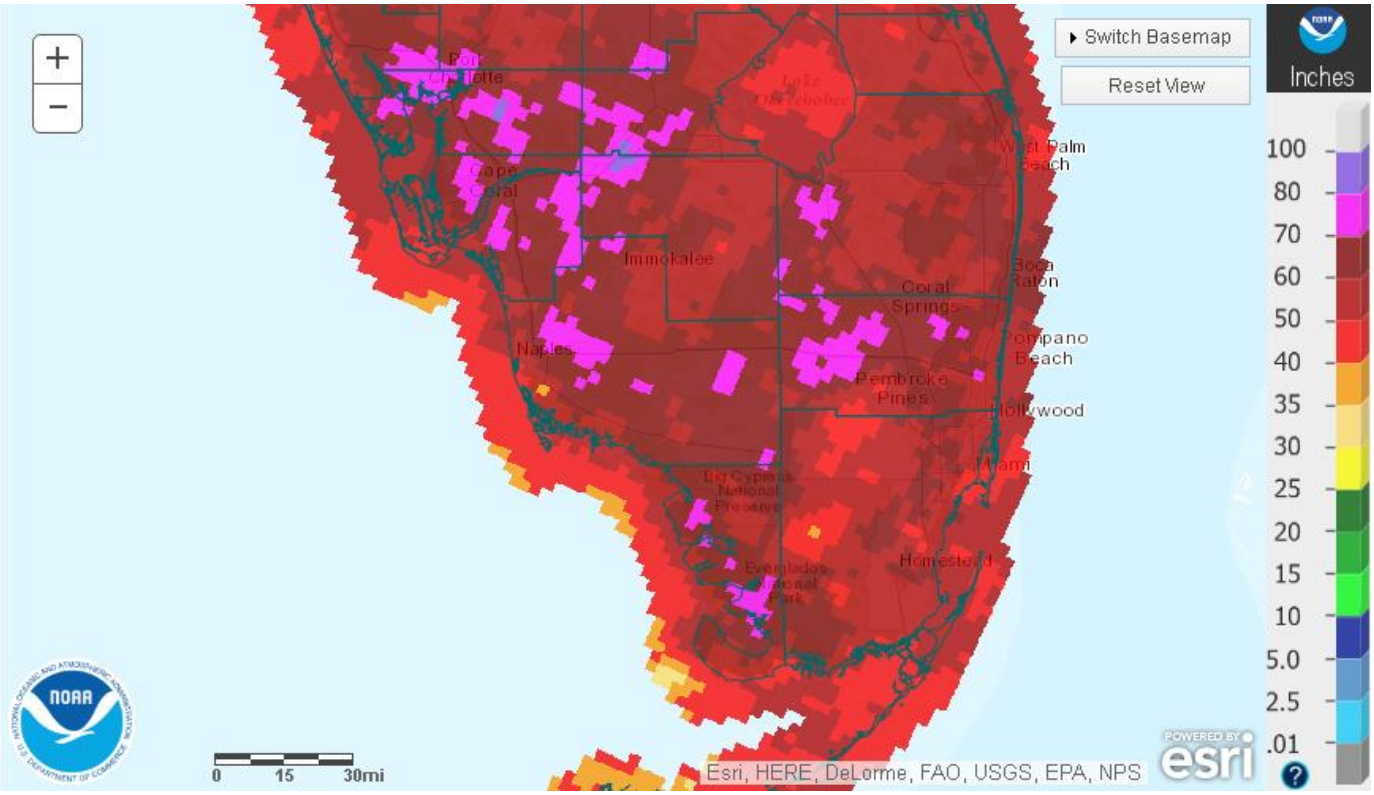
Winds were estimated to near 50 mph with these storms. Tragically, these storms led to a death from a lightning strike in Boynton Beach.

2016 Precipitation Data and Summary

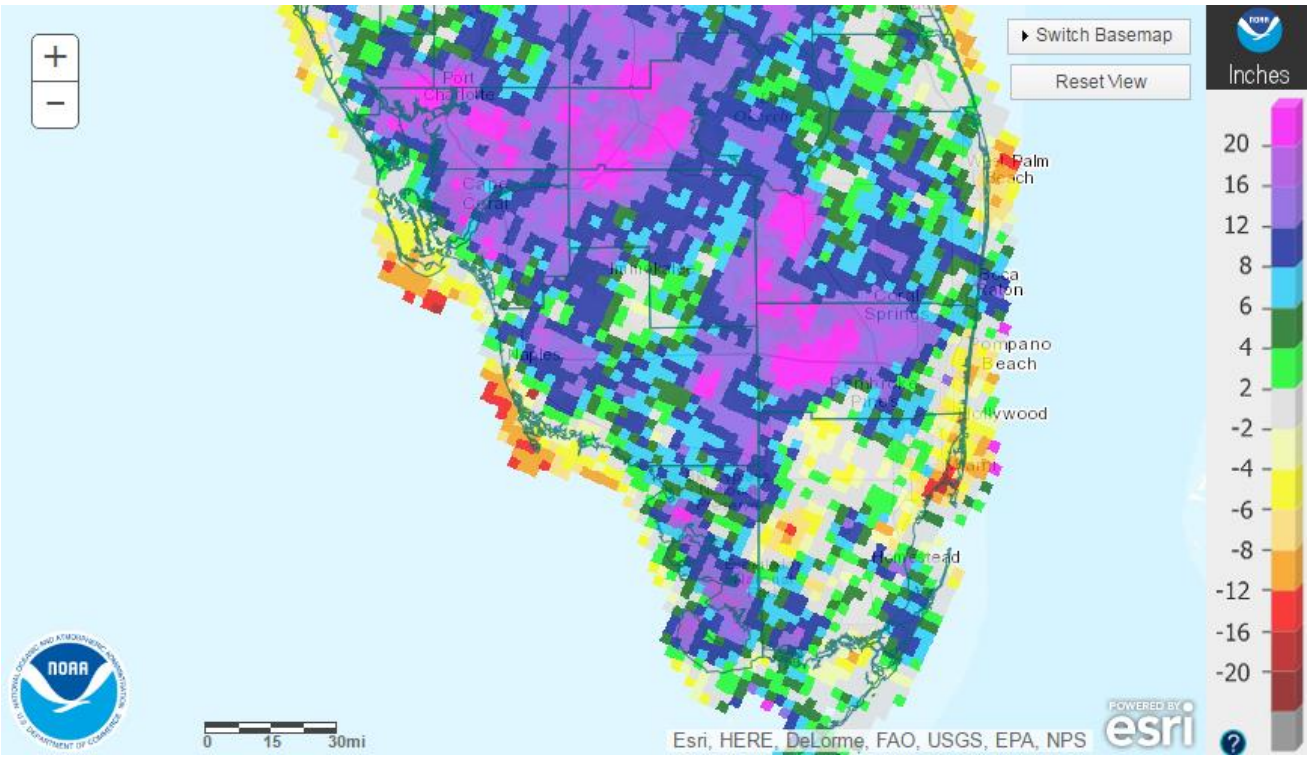
Below is a table of 2016 rainfall measured at NWS Cooperative Observation (COOP) and airport sites along with departures from normal and rank. Data is through 12/29. *NOTE: Normals are for period 1981-2010*

Location (Beginning of Period of Record)	2016 Rainfall (inches)	Departure from Normal	Rank (top 20)
Brighton Reservation – Glades County	49.73		
Canal Point (1941)	51.44	-1.17	
Cape Florida	50.87		
Fort Lauderdale/Hollywood Int'l Airport (1913)	50.30	-11.88	
Fort Lauderdale Beach	67.95		
Fort Lauderdale Dixie Water Plant	55.57		
Fort Lauderdale Executive Airport	50.31		
Hialeah (1940)	60.31	-10.07	
Hollywood Waste Water Plant	54.90	-7.28	
Homestead General Airport (1990)	58.48		
Immokalee (1970)	57.01	+7.19	10th wettest
Juno Beach	52.42		
LaBelle (1929)	65.79	+12.85	7th wettest
Marco Island	57.67		
Miami Beach (1927)	58.08		
Miami International Airport (1911)	65.93	+4.03	
Moore Haven (1918)	56.33	+9.38	
Muse	59.40		
Naples East/Golden Gate	69.35		
Naples Municipal Airport (1942)	44.44	-7.45	
North Miami Beach	67.06		
NWS Miami – Sweetwater	70.00		
Oasis Ranger Station (1978)	57.24	-0.99	

Opa-Locka Airport	**47.50**		
Ortona	**64.46**	**+9.01**	**5th wettest**
Palm Beach Gardens	**57.84**		
Palm Beach Int'l Airport (1888)	**51.08**	**-11.25**	
Pembroke Pines – North Perry Airport	**46.34**		
Pompano Beach Airpark	**45.38**		
The Redland - Miami-Dade County (1942)	**60.43**	**-2.17**	
South Bay/Okeelanta	**59.51**		
West Kendall – Miami Executive Airport	**63.54**		



2016 Year-to-Date Rainfall in Inches Ending December 29th



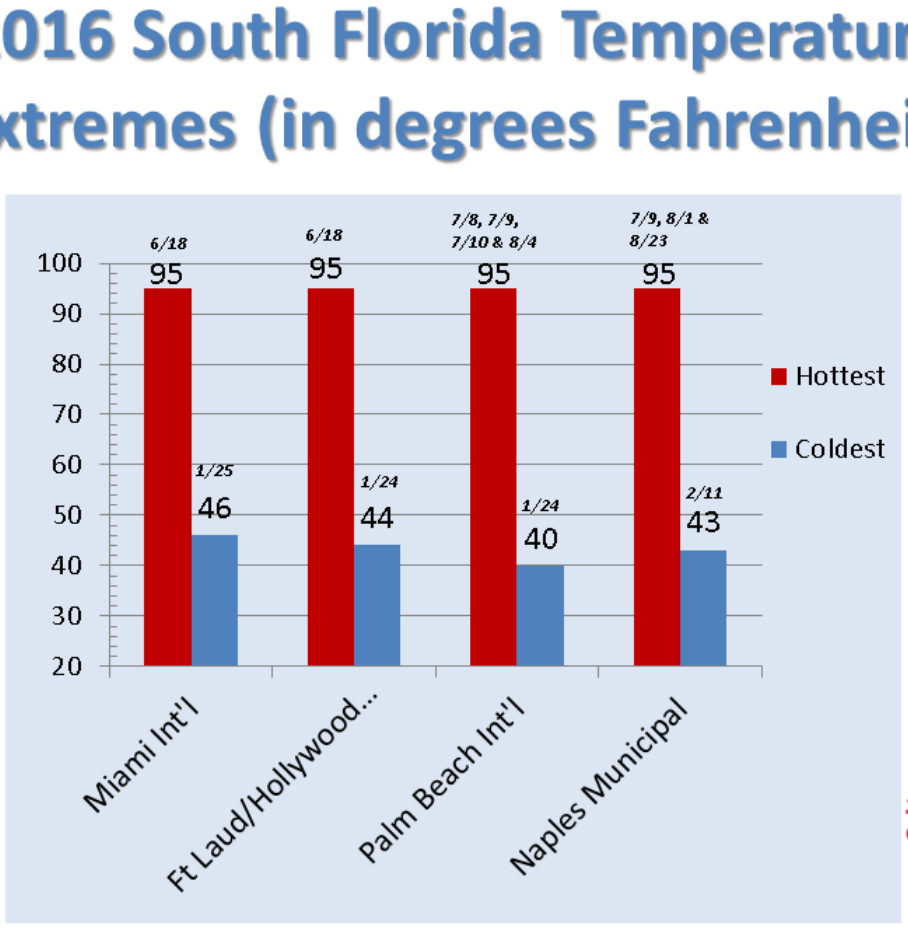
2016 Year-to-Date rainfall departure from normal in inches ending December 29th

Precipitation patterns were topsy-turvy in 2016 as our normally dry winter ended being the wettest on record based on South Florida Water Management District records. It was soon followed by dry summer in at least parts of South Florida. Summer rainfall exhibited a clear east-to-west trend of drier to wetter than normal. Most of the Southeast Florida metro area was 3 to 5 inches below normal, with some locations as much as 8 to 10 inches below normal. Around Lake Okeechobee, rainfall was 3 to 5 inches below normal, and as much as 9 inches below normal in Clewiston. Some areas west and south of Lake Okeechobee, on the other hand, were wetter than normal this summer by as much as 3 to 7 inches. The remainder of the rainy season was near normal, followed by a drier than normal late October/November. December was also drier than normal over western areas but near to above normal east.

Overall, the wet winter and summer over interior sections led to a wetter-than-normal year over these areas, exemplified by Ortona and LaBelle having their 5th and 7th wettest calendar year on record, respectively (see table above). The longer and drier summer more than offset the wet winter along parts of the Southeast Florida metro area, with West Palm Beach, Fort Lauderdale and Hialeah more than 10 inches below normal for the year.

2016 Temperature Data

Location (beginning of historical record)	2016 Avg Temp (F) through 12/29	Departure From Normal (F)	Rank through 12/29
Miami Int'l (1895)	78.2	+1.0	3rd warmest
Fort Lauderdale Int'l (1912)	77.9	+0.2	T-4th warmest
Palm Beach Int'l (1888)	77.3	+1.9	5th warmest
Naples Municipal (1942)	76.5	+1.4	T-5th warmest



January and February started out the year near to even slightly below normal as the typical El Niño pattern of cooler than normal daytime temperatures prevailed. Low temperatures during this period were mainly above average, and no official NWS station

recorded temperatures at or below freezing the entire year. From that point on, the year was quite warm. March and June were top 10 warmest months on record, and July was the hottest on record at West Palm Beach and Fort Lauderdale. Summer 2016 tied for the hottest on record at West Palm Beach. December will end up among the top 3 warmest on record.

The lowest observed temperature in southern Florida by NWS sites was **34 degrees in Ortona in southern Glades County on January 25th.**

By contrast, the hottest recorded temperature by NWS sites was 100 degrees at Royal Palm Ranger Station in Everglades National Park on August 6th.

A total of 95 daily warm records (minimum and maximum) were set at the four main climate sites above in 2016, compared to only 3 daily cold records.

Some other noteworthy 2016 temperature statistics:

- **Miami International Airport (MIA)** observed only 1 day of temperatures below 50 degrees. The average number of sub-50 degree days per year is 14. Miami also had 108 days of 90 degrees or higher, above the 30-year average of 87 days.

- **Palm Beach International Airport (PBI)** observed only 13 days of temperatures below 50 degrees which is well below the 30-year average of 22 days. West Palm Beach also had 100 days of 90 degrees or higher, well above the 30-year average of 69 days.

- **Naples Municipal Airport (APF)** observed 11 days of temperatures below 50 degrees which is well below the average of 23 days. Naples also had 112 days of 90 degrees or higher, above the 30-year average of 106 days.

- **Fort Lauderdale/Hollywood International Airport (FLL)** observed only 4 days of temperatures below 50 degrees which is well below the average of 11 days. Fort Lauderdale also had 71 days of 90 degrees or higher, above the 30-year average of 61 days.

Severe Weather and Weather-Related Deaths/Injuries/Impacts:

A reported total of five (5) people died in south Florida from weather-related incidents in 2016 (down from 8 in 2015) and an additional reported 16 were injured (down from 30 in 2015).

Rip currents accounted for 4 deaths and lightning accounted for one death. Below is additional information on other hazards:

- 3 injuries resulted from rip currents from rescued swimmers requiring medical attention.

- There were a total of 13 reported lightning events resulting in 1 death and 10 injuries. Damage to structures totaled over $260,000.

- A total of 9 tornadoes were reported in 2016 (one more than the yearly average). All of these occurred in January, February and March, and six occurred in one day (February 16th). Of the 8 tornadoes that were assigned ratings, 4 were EF-1 and the other 4 EF-0. A total of 3 injuries were reported and damage was estimated at just over $1 million. An additional injury was caused by strong thunderstorm winds in Hollywood on February 16th.

Flooding: 1 damaging flood event (Boca Raton on 3/24) which closed streets and led to approximately $50,000 in damage. In addition, there were 4 nuisance flood events caused by heavy rain and two minor coastal storm surge events (both in Collier County).

Tidal flooding due to astronomical high tide (king tides) took place in mid-October and again in mid-November along and near the Intracoastal Waterway in Southeast Florida from south of Downtown Miami all the way to West Palm Beach. Reports of street flooding were received from 28 locations.

Severe Thunderstorms and Hail: a total of 31 severe thunderstorm wind reports (58 mph or greater) were received, which is slightly higher than the 25-year average of 29. Damage from these winds is estimated at $63,000, but this does not include the Naples severe thunderstorm event of January 17th which likely would put the total for the year at well over $100,000. A total of 21 reports of hail three-quarters of an inch or greater were received, which is greater than the 25-year average of 18.

(Reference for historical tornado, severe thunderstorm wind and hail statistics: http://www.weather.gov/media/mfl/research/MFLSVRCLIMO_2013.pdf