

&

~ Hurricane Season Review ~

St. Maarten experienced drought conditions in 2016 with no severe weather events.



All Photos compliments Paul G. Ellinger

METEOROLOGICAL DEPARTMENT ST. MAARTEN



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Page 2 of 28

Table of Contents

| Introduction | 4 |
|--|------------|
| Island Climatology | 5 |
| About Us | 6 |
| 2016 Hurricane Season | |
| Local Effects | 8 |
| Summary | 9 |
| Overview of Storms formed | 10 |
| 2016 Climate Data | |
| Rainfall | 13 |
| Temperature | 15 |
| Wind | 17 |
| Air Pressure | 20 |
| Cloud Cover | 20 |
| Sunshine Duration | 21 |
| Summary | 22 |
| Conclusion | 23 |
| Outlook for 2017 | |
| Rainfall Outlook for Feb-Mar-Apr 2017 | 24 |
| 2017 Tropical Cyclone Names | 25 |
| Appendix | |
| Stages of Tropical Cyclone Development | 26 |
| Saffir-Simpson Hurricane Scale | 2 7 |
| Watches & Warnings | 2 7 |

Introduction

The country of St Maarten is located in the extreme northeast section of the Eastern Caribbean. It is part of an island which is approximately 37 square miles shared by two countries: French St. Martin to the north and Dutch St. Maarten to the south, which occupies 16 square miles. The island is relatively flat but has a central range with various peaks. Pic Paradise on the French side is the highest point (1400ft) on the island.



The Princess Juliana International Airport (TNCM) is located on the south western strip of St. Maarten at latitude 18.02° north and longitude 63.06° west.

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Page 4 of 28

ISLAND CLIMATOLOGY

Based on records (1981-2010) at Princess Juliana International Airport (PJIA), the normal annual rainfall is approximately 1170mm or 46 inches. Like many other Caribbean islands, the driest months are from January to June while the wettest months are from July to November. December, May and June can be considered as transition months since they can be either dry or wet.

The driest month on record is March while the wettest is November. On average there are about 145 rain days a year with April having the least (8 days) and November the most (15 days). Rainfall during December to April is produced mainly from old frontal boundaries or shear lines dipping southwards from northeast coast of the United States while the rainfall during May and June are often associated with upper level trough interactions and from July onwards, rainfall is mostly from tropical cyclones.

The normal daily average temperature is 27 °C or 81 °F, the normal maximum and minimum temperatures are 32 °C and 23 °C respectively. August and September are the warmest months while February is the coolest.

On average St. Maarten receives approximately 250 hours of sunshine monthly and 8 to 10 hours daily. The months with the most sunshine hours are March and April and the least hours are recorded in November.



The Meteorological Department of St. Maarten (MDS) — most commonly referred to as the Met. Office — is a scientific organization that operates 24 hours a day, all year round, monitoring and continuously keeping watch of the weather conditions across the island.

Our aim is to protect life and property, by providing reliable meteorological services in support of the social and economic development of the country through monitoring and predicting weather & climate, using up-to-date technology to enable optimal utilization of resources. We issue appropriate weather forecasts and warnings for St. Maarten, its adjacent waters and air space.

The vision of the Meteorological Department of St. Maarten is to achieve excellence in meteorological science, and the provision of quality weather and climate services.



2016 Hurricane Season

The 2016 Atlantic Hurricane Season was the first above normal season since 2012. The season stretched from January to November. NOAA's latest prediction (August) was for a near normal season with 12-17 named storms, 5-8 hurricanes with 2-4 major hurricanes.

Actually, there were 15 named storms, 7 hurricanes with 3 major hurricanes. Three storms, Gaston, Matthew and Nicole became major hurricanes. Major hurricanes are those reaching category 3 and above.

Hurricane Alex formed in the month of January, making it the first Atlantic hurricane to form in the month of January since 1950. This reminded us that tropical cyclone development is possible outside of the June 1st to November 30th season.

Hurricane Matthew was the only storm which tracked through the Eastern Caribbean and made land fall in Haiti on October 4th 2016. Matthew was the first category 5 hurricane (160 miles per hour) in the Atlantic basin since Hurricane Felix in 2007. It was also the strongest and the longest-lived storm of the season. Matthew lasted as a major hurricane for eight days from September 30^{th} to October 7^{th} .

| | NORMAL | NOAA'S PREDICTION | ACTUAL |
|---------------------|--------|----------------------|--------|
| NAMED STORMS | 12 | 12-17 | 15 |
| HURRICANES | 6 | 5-8 | 7 |
| MAJOR HURRICANES | 3 | 2-4 | 3 |
| | - | 1 = 00 | |

Local Effects

There were no impacts from any of the storms which formed during the 2016 hurricane season on the island of St. Maarten. However, two tropical waves had minor impacts on the island. Special advisories had to be sent out and schools and some business were ordered to close due to inclement weather and the threat posed to the island. On August 24th a wind gust of 47 kts or 54 mph was recorded about 10:20 am and on September 5th a gust of 36 kt or 41 mph was recorded about 04:38 am during the passage of active tropical waves through the island chain.

Summary

Below is a recap of the 2016 Atlantic Hurricane Season and in relation to its effects on St. Maarten.

| | Storm Name | Active Dates | Highest Category | Min. Pressure (mbar) | Max. Winds Kt. Mph | | Max. Winds | | Local Effects | Observed Rainfall | Observed Winds Gusts | |
|----|---------------|-------------------|------------------------------|----------------------------|--------------------------|------------|---------------|------|------------------|----------------------|----------------------------|--|
| | | | | | | | | (mm) | Kt. Mph | | | |
| 1 | Alex | Jan 12 — 15 | Hurricane Cat. 1 | 981 | 75 | 75 86 None | | - | - | - | | |
| 2 | Bonnie | May 27 — Jun. 4 | Tropical Storm | 1006 | 40 | 46 | None | - | - | - | | |
| 3 | Collin | Jun. 5 — 7 | Tropical Storm | 1001 | 45 | 52 | None | - | - | - | | |
| 4 | Danielle | Jun. 19 —21 | Tropical Storm | 1007 | 40 | 46 | None | - | - | - | | |
| 5 | Earl | Aug. 2 — 6 | Hurricane Cat.1 | 979 | 75 | 86 | None | - | - | - | | |
| 6 | Fiona | Aug. 16 —23 | Tropical Storm | 1004 | 45 | 52 | None | - | - | - | | |
| 7 | Gaston | Aug. 22 —Sept. 2 | Major Hurricane Cat. 3 | 955 | 105 | 121 | None | - | - | - | | |
| | TD Eight | Sept. 8 — 11 | Depression | 1010 | 30 | 35 | None | - | • | - | | |
| 8 | Hermine | Aug. 28 — Sept. 3 | Hurricane Cat. 1 | 981 | 70 | 81 | None | - | - | - | | |
| 9 | Ian | Sept. 12 — 16 | Tropical Storm | 994 | 55 | 63 | None | - | - | - | | |
| 10 | Julia | Sept. 13 — 18 | Tropical Storm | 1007 | 45 | 52 | None | - | - | - | | |
| 11 | Karl | Sept. 14 — 25 | Tropical Storm | 988 | 60 | 69 | None | - | - | - | | |
| 12 | Lisa | Sept. 19 — 25 | Tropical Storm | 999 | 45 | 52 | None | - | - | - | | |
| 13 | Matthew | Sept. 28 — Oct. 9 | Major Hurricane Cat. 5 | NA | NA | NA | None | - | - | - | | |
| 14 | Nicole | Oct. 4 — 18 | Major Hurricane Cat. 4 | 950 | 120 | 138 | 8 None - | | - | - | | |
| 15 | Otto | Nov. 20 — 26 | Hurricane Cat. 2 | 975 | 100 | 115 | - None | | - | - | | |

Overview of the Storms formed in the 2016 Hurricane Season

Hurricane Alex (Jan. 12th to 15th)

Alex was a very unusual January hurricane in the northeastern Atlantic. It became a hurricane on the 14th of January and made landfall in the Azores on January 15th. It became extratropical and was absorbed by an extratropical low over the far north Atlantic.

Tropical Storm Bonnie (May 27th to June 4th)

Tropical Storm Bonnie was formed from non-tropical origins northeast of the Bahamas on May 28th. During the days following, Bonnie made a slow loop over coastal South Carolina and slowly weakened. By June 2nd Bonnie had moved eastward and regained tropical cyclone status. It then moved over 22 °C waters and weakened to a low which dissipated south southwest of the Azores.

Tropical Storm Collin (Jun. 5th to 7th)

Tropical storm Collin formed on June 5th near the Gulf of Mexico. Collin never became a well-organized system since it was affected by strong shear. The storm moved northwards over Florida and emerged over the Atlantic and became a frontal low.

Tropical Storm Danielle (August 19th to 21st)

Danielle was a short-lived tropical storm which made landfall in eastern Mexico on June 20^{th} . It later weakened and dissipated the next day.

Hurricane Earl (August 2nd to 6th)

Hurricane Earl formed south of Jamaica on August 2nd. It made landfall in Belize and crossed Guatemala into southern Mexico. Earl was responsible for 81 deaths in Mexico. After moving westward across Mexico, its remnants helped trigger the development of Tropical Storm Javier in the eastern Pacific.

Tropical Storm Fiona (August 16th to 23rd)

Fiona was a tropical storm that formed in the far eastern Atlantic on August 17th and moved west-northwestward without strengthening much. The storm reached the subtropical Atlantic and weakened primarily due to strong shear, dissipating nearly midway between Puerto Rico and Bermuda.

Major Hurricane Gaston (August 22nd to September 2nd)

Gaston was developed from a strong tropical wave near the Cape Verde Islands on August 22^{nd} . Gaston then strengthened into a hurricane on August 24^{th} and turned toward the northwest over the central Atlantic. It became stationary near Bermuda and then proceeded toward the northeast over cooler waters and became a post-tropical cyclone near the Azores on September 2^{nd} .

Tropical Depression Eight (August 28th to September 1st) Tropical Depression Eight was a short-lived tropical depression. Formed on August 28th near Bermuda and dissipated on September 1st east of Virginia.

Hurricane Hermine (August 28th to September 3rd)

Hermine originated from a depression which was formed days earlier near Cuba and had drifted westwards into the Gulf of Mexico. Upper level winds made it tough for Hermine but it managed to reach hurricane intensity when it moved to the northeast and made landfall in Florida on September 2nd. Thereafter, Hermine weakened and became extratropical as it moved eastwards over the Atlantic.

Tropical Storm Ian (September 12th to 16th)

Ian was a sheared cyclone which spent its lifetime over the Atlantic Ocean. Tropical Storm Ian formed on the 12th of September southeast of Bermuda and became a subtropical storm for a short period on September 14th. It was then absorbed by an extratropical low in the north Atlantic.

Tropical Storm Julia (September 13th to 18th)

Julia developed between south Florida and the Bahamas on September $13^{\rm th}$. Julia was short lived and had minor impacts on land. On the $14^{\rm th}$ it turned to the north and northeast and began to weaken.

Tropical Storm Karl (September 14th to 25th)

Tropical Storm Karl was formed on September 15^{th} in the eastern Atlantic, became a depression on September 21^{st} and regain tropical storm strength on the 22^{nd} . The system moved rapidly to the northeast and became extratropical.

Tropical Storm Lisa (September 19th to 25th)

Lisa originated from a depression which formed near the Cape Verde islands on September 19^{th} and intensified to a tropical storm the next day. Lisa remained a weak storm over the Atlantic for several days and degenerated into a trough on September 25^{th} .

Major Hurricane Matthew (September 28th to October 9th)

Mathew became a tropical storm east of the Windward Islands on September 28th. It continued on a westward track into the Caribbean Sea and became a hurricane the following day. Mathew continued to intensify over warm Caribbean waters, then took a northerly track and made landfall over the western trip of Haiti as a category 5 hurricane. Wreaking havoc over the island, leaving billions of dollars in damage and many lives lost. Mathew then headed through the Bahamas, grazed the eastern coast of the US and finally made its way into the northern Atlantic.

Hurricane Nicole (October 4th to 18th)

Nicole became a tropical storm north of Puerto Rico on October 4^{th} . The storm moved northwest, encountered some shear then became stationary. As the shear diminished Nicole became better organized and rapidly intensified to a hurricane south of Bermuda at 8pm on October 6^{th} then weakened the next day back to a tropical storm. For the next few days Nicole intensified and weakened yet again. By October 18^{th} Nicole had drifted into cooler waters and become extratropical.

Hurricane Otto (November 20th to 26th)

Otto was formed late in the season and became a category 3 hurricane before making landfall in Nicaragua. Otto became a rare Atlantic-to-Pacific storm as it moved across southern Nicaragua and emerged over the Pacific Ocean as a tropical storm.



2016 Atlantic Hurricane Season Storm Track

MDS Climatological Summary 2016

Map compliments "The Weather Channel"

<u>2016 Climate Data</u> <u>Rainfall</u>

The total rainfall recorded at the Princess Juliana International Airport, for the year 2016 was **816.6 mm or 32.1 inches**. This was the second year in a row that rainfall was below the normal range. The normal annual rainfall is about 1026 mm - 1274 mm/40 - 50 inches (1981–2010). This year's total was about 70% of the normal annual rainfall.





December was the *wettest month* of the year, with a total of 155.5 mm or 6.1 inches; while the *driest month* was **June** with 6.4 mm or 0.3 of an inch. The *wettest day* of the year was **November 3rd**, when 38.1 mm or 1.5 inches was recorded which was as a result of instability associated with a frontal boundary across the area.



A rain day is considered any day which records 1.0 mm or more of rainfall. Normally there are approximately 145 rain days in a year on St. Maarten. For 2016, there were 128 rain days with the month of December having the most (19 days) followed by July with fourteen (14) days.

There were not many records set in 2016. October 2016 was the driest October on our records since 1953. June was exceptionally dry, the driest since 2012 while September was the wettest September since 2011.



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Page 14 of 28

Temperature

The average temperature recorded in 2016 was 27.6° C (82° F) which was above normal. The 30-year normal (1981–2010) is 27.2° C. August was the warmest month with an average temperature of 29.1° C (84° F) while March was the coolest month with an average temperature of 26.0° C (79° F). There was a variation of about 3.1° C between the warmest and coolest months.



The highest daily *temperature* recorded in 2016 was **32.8**° **C** (**91**° **F**) and was recorded on August 26th and September 4th while the lowest daily *temperature* was recorded on March 12th as **21.7**° **C** (**71**° **F**). The difference between the maximum and minimum temperatures recorded was **11.1**° **C**.





Annual Average temperature for the past 15 years has been below normal most of the time and becoming near normal to above normal in the most recent years.

Wind

Surface wind at the Princess Juliana International Airport for 2016 was generally from the east at an average speed of **9.0 knots** (10 mph) which was near <u>normal</u> compared to the 30–year average (1981–2010). The *highest monthly average wind speeds were recorded in* **March** and **July** as 11 knots (13 mph); while **October** had the *lowest monthly average wind speeds* at 7 knots (8 mph).

The *highest wind gust* for the year occurred on August 24th at a speed of 47 knots (54 mph). This was during the passage of a tropical wave through the region.



This following wind analysis was obtained, by using the average hourly wind speeds and direction from 1st January to 31st December 2016.



- > Approximately 51% of the time, wind speeds at Juliana were between 5 and 10 knots.
- > Approximately 35% of the time, wind speeds were between 10 and 15 knots.
- > Approximately 10% of the time, wind speeds were between 1 and 5 knots.
- > Approximately 3% of the time, wind speeds were between 15 and 20 knots.
- > Less than 1% of the time, speeds were than 20 knots or calm.



41% of the time winds came from the East.
21% of the time winds came from the East-southeast.
19% of the time winds came from East-northeast.
10% of the time winds came from the Southeast.
4% of the time winds came from the Northeast.
2% of the time winds came from the South-southeast.
Winds came from other directions 1% or less.

Air Pressure

At the Princess Juliana International Airport, on average the Mean Sea-Level Pressure for 2016 was **1015.9 millibars**. The Highest daily average was recorded on June 15^{th} as 1021.1 mb while the lowest daily average of 1008.7 mb occurred on November 1^{st} .



Cloud Cover

The average cloud cover for St. Maarten over the past year as recorded at the Princess Juliana International Airport was about 53.4%. The *highest monthly average cloud cover* was 65.4% during the month of **November** while **February** had the *lowest value* of 40.2%.



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Page 20 of 28

Sunshine Duration

Approximately 66% of possible sunshine was recorded at the surface at the Princess Juliana International Airport, that is, 2917.9 hours out of a possible 4443.1 hours. The *average daily sunshine duration* was **8 hours 6 minutes**.

March received the most hours of sunshine in 2016, while **November** received the least. Daily average sunshine was the highest in the month of August; 9 hours and 00 minutes per day; while the lowest average was recorded in the month of November as 6 hours 30 minutes per day.

Maximum daily sunshine hours was recorded on **April 16th** as <u>11 hours 24 mins</u>. There were three (3) days when no sunshine was recorded due to overcast conditions: **May 28th**, **September 5th** and **November 28th**.





Statistic Summary

Below is a recap of the 2016 climate data, in terms of averages, extremes, and totals:

| Rainfall | | | | | | |
|--|--|--|--|--|--|--|
| Total Rainfall for the year | 816.6 mm | 32.1 inches | | | | |
| Wettest Month | 155.5 mm/6.1 in | December | | | | |
| Driest Month | 6.4 mm/0.3 in | June | | | | |
| 24-hr Maximum Rainfall | 38.1 mm/1.5 in | November 3 rd | | | | |
| Number of Rain Days (with 1.0+ mm)128 days | | | | | | |
| Number of Heavy Rain Days (with 10.0+mm) | 2 | 6 days | | | | |
| Temp | erature | | | | | |
| Average Air Temperature | 27.6° C | 82° F | | | | |
| Absolute Maximum Temperature | $22.8^{\circ} C/01^{\circ} F$ | August 26 th & | | | | |
| | 32.0 C/ 91 F | September 4 th | | | | |
| Absolute Minimum Temperature | 21.7° C/ 71° F | March 12 th | | | | |
| Warmest Month | 29.1° C/84° F | August | | | | |
| Coolest Month | 26.0° C/79° F | March | | | | |
| Average Relative Humidity 77% | | | | | | |
| Wind & Pressure | | | | | | |
| Average Wind Speed | 9.0 knots | 10 mph | | | | |
| Average wind Direction | 97 degrees | East | | | | |
| Maximum Wind Gust | 47 knots/54 mph | August 24 th | | | | |
| Most frequent category speed | 5-10 knots | 51% | | | | |
| Average Air Pressure | 1015.9 mb. | | | | | |
| Clouds & | x Sunshine | | | | | |
| Average Cloud Coverage | 53.4% | | | | | |
| Average Daily Sunshine Duration | 8 hours : 06 minutes | | | | | |
| Month: Maximum Sunshine | March | | | | | |
| Month: Minimum Sunshine | November | | | | | |
| Daily Maximum Sunshine | 11 hrs. 24 min. April 16 th | | | | | |
| Daily Minimum Sunshine | o min. | May 28 th , Sept. 5 th & Nov. 28 th | | | | |
| MDS © I | March 2017 | Pag | | | | |

Conclusion

This report provides a summary of all the meteorological data recorded at the Princess Juliana International Airport during the year 2016. The data was collected from various meteorological parameters under regulations stipulated by the World Meteorological Organization (WMO). These elements include rainfall, relative humidity, atmospheric pressure, wind speed and direction, cloud cover and sunshine duration among others.

The Meteorological Department St. Maarten (MDS) records and compiles climatological data for use in research in a number of fields and institutions. Records go as far back as the 1950's in certain parameters. Requests for data must be put in writing through the Department Head.



Map compliments: CARICOF; <u>Caribbean Institute for Meteorology & Hydrology</u>

Rainfall for the next three (3) months Mar–Apr–May 2017 is expected to be near to above normal for most of the Greater Antilles, Trinidad and eastern Guianas. Elsewhere, there is low predictability this season. There is an equal chance for either above or below normal rainfall to occur in St. Maarten. Normal rainfall for this season ranges between 162.5 mm – 262.0 mm or 6-10 inches. Based on historical data, the current state of the weather and some subjective input, St. Maarten is likely to experience **an equal chance of either category** during the next three (3) months. There is a **33%** chance of being *Above Normal* (more than 262.0 mm); a **33%** chance of being *Near Normal* (between 162.5 mm and 262.0 mm); and a **33%** chance of being *Below Normal* (less than 162.5 mm).

Note that St. Maarten is pointed by the blue arrow and the forecast probabilities are circled in blue on the map above.

List of Tropical Cyclone for the 2017 Atlantic Hurricane Season

| ARLENE | HARVEY | OPHELIA |
|------------------------------|--------|----------|
| • BRET | IRMA | PHILIPPE |
| - CINDY | JOSE | RINA |
| - DON | KATIA | SEAN |
| • EMILY | LEE | TAMMY |
| FRANKLIN | MARIA | VINCE |
| • GERT | NATE | WHITNEY |

BE PREPARED!!! BE ALERT!!! BE READY!!!

Be reminded that it only takes one storm to impact our island to make it an active season for us. Therefore, Everyone should prepare for every season, regardless of how much activity is predicted.

<u>Appendix</u>

Stages of Tropical Cyclone Development

Below are the decisive factors (criteria) for the various development stages for tropical cyclones:

| Stage | Criteria | | | |
|------------------------|--|--|--|--|
| Tropical disturbance | A discrete system of clouds, showers, and thunderstorms that originates in the tropics and maintains its identity for 24 hours or more. | | | |
| Tropical wave | A type of trough of low pressure or tropical disturbance that moves generally from east to west, typically embedded in the tropical easterlies. They are also sometimes called easterly waves. | | | |
| Tropical Depression | A tropical disturbance that has developed a closed circulation (counterclockwise winds blowing around a center of low pressure in the Northern Hemisphere). Tropical depressions contain maximum sustained (1-minute) winds of 38 mph (62 km/h or 33 knots) or less. | | | |
| Tropical Storm | A well-organized warm-core tropical cyclone that has maximum sustained (1-minute) winds of 39-73 mph (63-118 km/h or 34-63 knots). Once a system reaches tropical storm status, it is given a name by the National Hurricane Center (located in Miami, Florida). | | | |
| Hurricane | A warm-core tropical cyclone that has maximum sustained (1-minute) winds of at least 74 mph (119 km/h or 64 knots). Hurricanes are categorized by the Saffir-Simpson Scale (<i>see next page</i>). | | | |
| Extra-tropical Cyclone | A cyclone that is no longer tropical in origin, which usually means the system moves away from the tropics and moves toward the poles. An extra-tropical cyclone has no wind speed criteria and may exceed hurricane force. | | | |
| Subtropical Cyclone | A closed circulation, low-pressure system that has characteristics of both tropical and extra-tropical cyclones. Subtropical cyclones typically have a radius of maximum winds occurring relatively far from the center (usually more than 60 nautical miles), and generally have a less symmetric wind field and distribution of convection (clouds and thunderstorms). | | | |
| Post-tropical Cyclone | A former tropical cyclone that no longer possesses sufficient tropical characteristics to be considered a tropical cyclone. Post-tropical cyclones can, however, continue carrying heavy rains and high winds. | | | |

Saffir-Simpson Hurricane Scale

The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage.

| | Category | Max. S | Sustained V | Effects | |
|-------|----------|-----------|-------------|-----------|------------------------|
| | cutogory | mph | km/h | knots | |
| | 1 | 74 - 95 | 119 - 153 | 64 - 82 | Minimal Damage |
| | 2 | 96 - 110 | 154 - 177 | 83 - 95 | Moderate Damage |
| Major | 3 | 111 - 129 | 178 - 208 | 96 -112 | Extensive Damage |
| | 4 | 130 - 156 | 209 - 251 | 113 - 136 | Extreme Damage |
| | 5 | 157+ | 252+ | 137+ | Catastrophic Damage |

Watches & Warnings

Tropical Storm Watch

Issued when tropical storm conditions (sustained winds of 39-73mph, 63-118 km/h, or 34-63 knots) are *possible* within the specified area within the next 48 hours (2 days).

Tropical Storm Warning

Issued when tropical storm conditions (sustained winds of 39-73mph, 63-118 km/h, or 34-63 knots) are *expected* somewhere within the specified area within the next 36 hours (1.5 days).

Hurricane Watch

Issued when hurricane conditions (sustained winds of 74 + mph, 119 + km/h, or 64 + knots) are *possible* within the specified area within the next 48 hours (2 days).

Hurricane Warning

Issued when hurricane conditions (sustained winds of 74+ mph, 119+ km/h, or 64+ knots) are *expected* within the specified area within the next 36 hours (1.5 days).

Note: Hurricane preparedness activities become difficult once winds reach tropical storm force, therefore, hurricane watches & warnings are issued well in advance of the anticipated onset of tropical-storm-force winds.

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