

## What Does Data Tell you about Atlantic Hurricanes?

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In 2017, several forecasters warned of an above average year for hurricane and tropical storm activity in the Atlantic. How many hurricanes had occurred in the Atlantic basin in the years since 2000?

Here are the numbers of hurricanes which had occurred in each of the years from 2000 through 2018:

8, 9, 4, 7, 9, 15, 5, 6, 8, 3, 12, 7, 10, 2, 6, 4, 7, **10**, 8

By all accounts, 2017 met the fears of the forecasters, producing 17 tropical storms *including 10 hurricanes*, four of which were classified as “major hurricanes.”

Go to [stapplet.com](http://stapplet.com) and click on “One Quantitative Variable.” Name the variable, Number of Hurricanes per Year and enter the numbers above as Raw data. Then click on Begin Analysis and explore the graphs and statistical output.

1. Describe the distribution of the numbers of hurricanes occurring in each year 2000-2018.
  - . The distribution of the number of hurricanes per year, 2000-2018, is roughly symmetric with a mean of 7.368 hurricanes and a standard deviation of 3.166 hurricanes.
2. Interpret the mean and the standard deviation of the number of hurricanes during the each of the years 2000-2018.
  - . A typical number of Atlantic hurricanes per year, based on 2000-2018, would be around the mean of 7.368 hurricanes. The annual Atlantic hurricane counts differ from the mean of 7.368 hurricanes per year by an average of 3.166 hurricanes.
3. How many hurricanes would *this* year need to produce in order to be declared an “outlier” for the number of hurricanes produced in the Atlantic basin? Check your answer by making a box plot in the applet with your answer for this year’s number of hurricanes included in the data.
  - . Sixteen storms this year would be six more than the third quartile (which would become 9.5 with the addition of the new data value of 16 added into the data set), far enough to be more than 1.5 IQRs above the third quartile.
  - . 16 is an outlier, because  $16 > 1.5 * 4 + 9$

## Irma and Maria: 2017's Terrible Two

The hyperactive 2017 hurricane season produced several terrible storms, but two really stood out. Not long after Hurricane Irma struck Cuba and then Southern Florida, along came hurricanes Jose, Katia, and Lee, but none of these packed the punch of the season's second hurricane to achieve Category Five status, Maria.

While Irma had left 64.76 billion dollars of damage and 52 people dead, Maria, with its 175mph winds and 908mb minimum air pressure was even more destructive, causing a whopping 91.606 billion dollars of damage and 3,057 deaths. Consider the following questions in comparing Maria with Irma.

1. How many mph was Maria's max wind speed above the average for all Atlantic hurricanes?
  - . Maria's max wind speed of 175 mph was 25.606 mph faster than the mean wind speed of all of these Atlantic hurricanes.
2. How many standard deviations above average was Maria's maximum wind speed?
  - . Maria's max wind speed was  $25.606 \text{ mph} / 15.8725 \text{ mph} = 1.61$  standard deviations above the mean wind speed of all of these hurricanes.
3. How many millibars was Maria's minimum air pressure below the average for all Atlantic hurricanes?
  - .  $908 \text{ mb} - 932.477 \text{ mb} = -24.477 \text{ mb}$ , so Maria's air pressure was 24.477 mb lower than the mean air pressure of all of these hurricanes.
4. How many standard deviations below average was Maria's minimum air pressure?
  - .  $24.477 \text{ mb} / 14.7087 \text{ mb} = 1.664$  standard deviations below the average pressure of all of these hurricanes.
5. 2017's previous big hurricane, Irma, had sustained winds of 185 mph and a minimum air pressure of 914 mb. Repeat the kind of calculations you did in (3) and (4) above for Irma. Then using your calculations of the number of standard deviations above or below average for Irma and Maria, write a few sentences about which of the two hurricanes was the more powerful storm.
  - . Irma was more impressive than Maria for its wind speeds, 2.24 standard deviations faster than the typical Atlantic hurricane, but Maria was slightly more impressive than Irma for its low air pressure, which was 1.664 standard deviations below the typical air pressure in an Atlantic hurricane. (While this tells which of these hurricanes were more unusual for these characteristics, answers will vary about which was more "powerful.")

## Dorian's Wind Speed

On 9/1/2019, Dorian was packing sustained winds of 185 mph. Did this make Dorian unusually powerful among Hurricanes recorded since 1959? Answer the following questions.

Cat 4-5 Atlantic Hurricanes 1959-present

|                 | Wind_Speed  |
|-----------------|-------------|
| S1 = mean ( )   | 149.394 mph |
| S2 = count ( )  | 66          |
| S3 = stdDev ( ) | 15.8725 mph |
| S4 = min ( )    | 130 mph     |
| S5 = Q1 ( )     | 140 mph     |
| S6 = median ( ) | 145 mph     |
| S7 = Q3 ( )     | 160 mph     |
| S8 = max ( )    | 215 mph     |

1. Describe the distribution of sustained wind speeds of Atlantic hurricanes since 1959.

The distribution of sustained wind speeds for Atlantic hurricanes since 1959 is skewed right with a median wind speed of 145 mph and an IQR of 20 mph.

2. Compare the two measures of center you find in the chart.

The mean wind speed of 149.394 mph is greater than the median wind speed of 145 mph.

3. What is the best reason you can give for the difference you observe in the two measures of center?

The mean wind speed is pulled higher than the median wind speed by the right skew of the distribution and/or the outlier at 215 mph.

4. Based on the statistics in the chart, would any of the Atlantic hurricanes between 1959 and the present be considered outliers for their max wind speeds? Is Dorian an outlier?

The maximum wind speed of 215 mph is an outlier, because  $215 > 1.5 * (160 - 140) + 160$ . Dorian's max wind speed of 185 mph is not an outlier because 185 is not greater than  $1.5 * (160 - 140) + 160$ , which equals 190 mph.

5. Interpret the standard deviation of the wind speeds of the hurricanes.

On average, the wind speeds of Atlantic hurricanes differ from the mean wind speed (149.394 mph) by 15.8725 mph.

6. How many mph above average was Dorian's maximum sustained wind speed?

Dorian's max sustained wind speed of 185 mph was 35.606 mph greater than the mean wind speed.

7. How many *standard deviations* above average was Dorian's max sustained wind speed?

$35.606 / 15.8725 = 2.24$ , so Dorian's max sustained wind speed is 2.24 standard deviations above the average for Atlantic hurricanes.

## Dorian's Air Pressure

Hurricanes are not only measured by their wind speeds. Another important consideration is their minimum air pressure: the lower the minimum air pressure, the stronger the hurricane. On 9/1/19, Dorian reached a minimum air pressure of 911 mb.

1. Describe the distribution of minimum air pressure for Atlantic hurricanes from 1959-present.

The distribution of minimum air pressures for Atlantic hurricanes is skewed left with a median pressure of 935 mb and an IQR of 21 mb.

2. How low would a hurricane's pressure need to be to be identified as an outlier?

In order to be a low outlier, a hurricane's pressure needs to be less than  $921 - 1.5 \cdot 21$ , or 889.5 mb.

3. How many millibars below average is Dorian's pressure?

Dorian's air pressure of 911 mb is 21.477 mb below the mean air pressure of Atlantic hurricanes.

4. How many *standard deviations* is Dorian's pressure below average?

Dorian's air pressure of 911 mb is  $21.477 / 14.7087 = 1.46$  standard deviations below the mean air pressure of Atlantic hurricanes.

Cat 4-5 Atlantic Hurricanes 1959-present

|                 | Pressure   |
|-----------------|------------|
| S1 = mean ( )   | 932.477 mb |
| S2 = count ( )  | 65         |
| S3 = stdDev ( ) | 14.7087 mb |
| S4 = min ( )    | 872 mb     |
| S5 = Q1 ( )     | 921 mb     |
| S6 = median ( ) | 935 mb     |
| S7 = Q3 ( )     | 942 mb     |
| S8 = max ( )    | 958 mb     |

## Your Assessment of Dorian

Write a few sentences assessing how Dorian compares among all Atlantic hurricanes since 1959, justifying your position using statistical reasons from the information provided above.

Dorian is a remarkable Atlantic hurricane, considering its air pressure reached 1.46 standard deviations lower than the mean air pressure of Atlantic hurricanes, but even more so for its max wind speeds, which are 2.24 standard deviations faster than the average Atlantic hurricane.