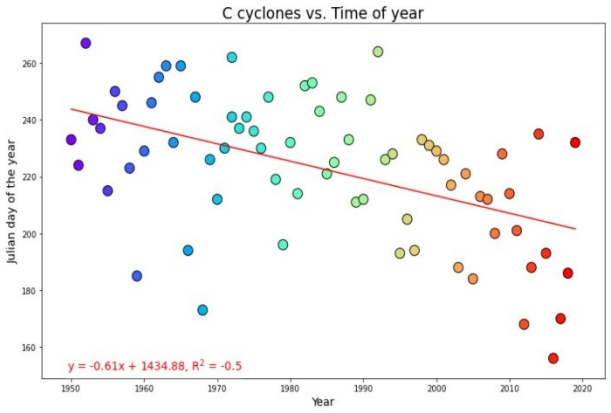
Question 1: How do we understand tropical storms, cyclones, and hurricanes?

Introduction:
When Tropical Depression Two-E formed off the Western Coast of Nicaragua on May 26, it was considered an innocuous low-pressure system that would mostly pass unnoticed. Tropical Depression Two-E though had other plans. Four days later Two-E became Tropical Storm Amanda, making landfall on Guatemala. During its short-lived reign as Amanda, the storm caused over $200 million in damages with 26 fatalities. But Amanda was only getting started.
The remnants of traveled across the isthmus of Central America and wound up in the Gulf of Mexico. It re-strengthened and became what we know as Tropical Storm Cristobal on June 2nd, 2020.
Cristobal went on to make two landfalls. The first landmark was in the state of Campeche, Mexico; the second occurred on June 7th in Southeastern Louisiana. While it never really organized well enough to make it to hurricane status, it remained in tropical status three days, finally dying over the Upper Peninsula of Michigan on June 10th.
The story of Cristobal is one that if it had happened later in the hurricane seasonal would have made it almost completely forgotten other than those were personally impacted it. But Cristobal did have one thing going for it: it shattered the record for the earliest named "C" storm in the history of the Atlantic basin, previously held by Colin in 2016.

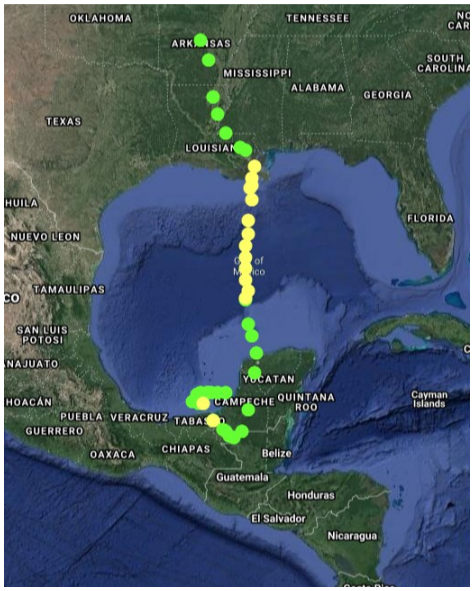
Problem Statement:
Tropical Storm Cristobal was the earliest named "C" storm in history. Are we seeing a trend with storms forming in the earlier part of the hurricane season? Or is this just an anomaly?



Datasets used:
Tropical Storm Cristobal tracking data from
https://www.flhurricane.com/
Historical Hurricane tracking data from the National Hurricane Center (National Oceanic and Atmospheric Administration)
https://www.nhc.noaa.gov/

Results: The data file we had from the National Hurricane Center had all storms that were tracked going back to the 1850s. While named storms did exist on a one-off basis up until 1950, it wasn't until 1950 that the National Weather Service adopted a naming convention for tropical systems, a series of 22 names pre-assigned to a given year, starting with the letter "A" and going alphabetically. Using this as the starting point, we identified when systems would be upgraded to a "named" storm. Systems do receive names until they reach a tropical storm status, a system will form over a body of water and will have sustained winds of at least 38 miles per hour. Using a scatterplot, each storm starting with the letter "C" was plotted against the Julian day of the year. Finally, a linear regression model was applied. The results were published using Matpotlib and can be found on the next page.

Conclusion: The linear regression does show a trend that "C" named storms are indeed occurring earlier in the year. Storms beginning with the letter "C" are now likely to form 30 days earlier than storms forming with the letter "C" back in the 1950s.



Track of Tropical Storm Cristobal

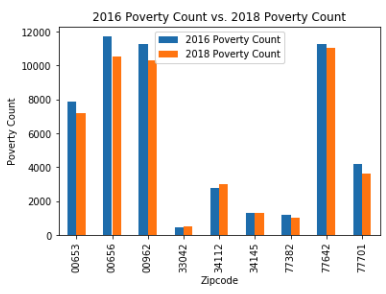
Question 2: What are **the demographics of an area before and after a storm?**

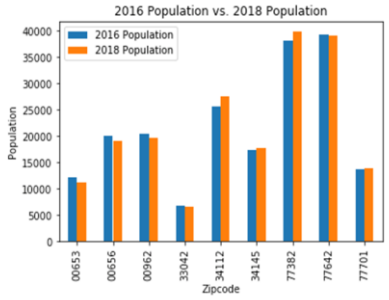
Introduction:
2017 was a significant year in the annals of Atlantic Basin hurricanes. Hurricane Harvey was the first in a trio of major hurricanes to hit the United States that year. Originally making landfall near Rockport, Texas it made two additional landfalls as it slowly meandered in an out of the coastal waters of Texas. Harvey's lethal weapon was rain and lots of it. Most areas of Southeast Texas received over 40 inches of rain over four days making Harvey wettest hurricane the United States has had in recorded history. By the end of it, Hurricane Harvey had caused over $125 billion in property damage tying it with Hurricane Katrina in 2005 as the most amount of property damage done by a hurricane.
Irma was next setting it's sight eventually towards the western side of the Florida Peninsula. Hitting Marco Island, Irma ran up the coast, hitting the cities of Sarasota, Bradenton, and the entire Tampa / St Petersburg metropolitan area. Irma didn't just hit the Western side – Irma was so large that many parts of Jacksonville, located in Northeast Florida, flooded. All told Hurricane Irma caused over $65 billion in property damage.
Finally, Maria, the third major hurricane of 2017, became the deadliest of the year. Maria's main damage in the US was in Puerto Rico, with sustained winds of 113 mph hitting the capital city of San Juan. All told Maria was attributed to 2,982 deaths on the tiny island, making it the third deadliest US hurricane in history. To answer our question, we will look at these catastrophic storms to help us answer our question: What are the demographics of the area before and after a storm.

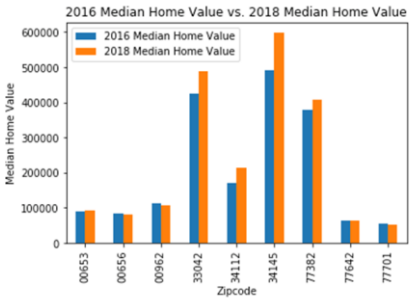
APIs and Data used:
2016 and 2018 US Census Bureau
We identified the top three zip codes with the most property damage for Hurricane Harvey, Irma, and Maria

Results:
For the Puerto Rico zip codes hit by Hurricane **Maria**, we saw that population decreased, poverty count decreased, and median home value decreased and increased depending on zip code.
For the Florida zip codes hit by Hurricane **Irma**, we saw that population and poverty count decreased and increased depending on zip code and median home value increased.
For the Texas zip codes hit by Hurricane **Harvey**, we saw that population and median home value decreased and increased depending on zip code and poverty count de-creased.

Conclusion:
Poverty, Population, and Median home value do not appear to have a strong correlation with hurricanes. The decrease in poverty count initially shows hurricanes do not negatively affect poverty count. However, it should also be considered that when a hurricane hits a city, those in poverty-stricken areas could move out of the region to other cities. Because of a lack of financial means, they might be able to support a move back home which in turn could decrease poverty count. Hurricanes do not have a negative effect on the median home value or population, as areas impacted, are still considered desirable places to live.







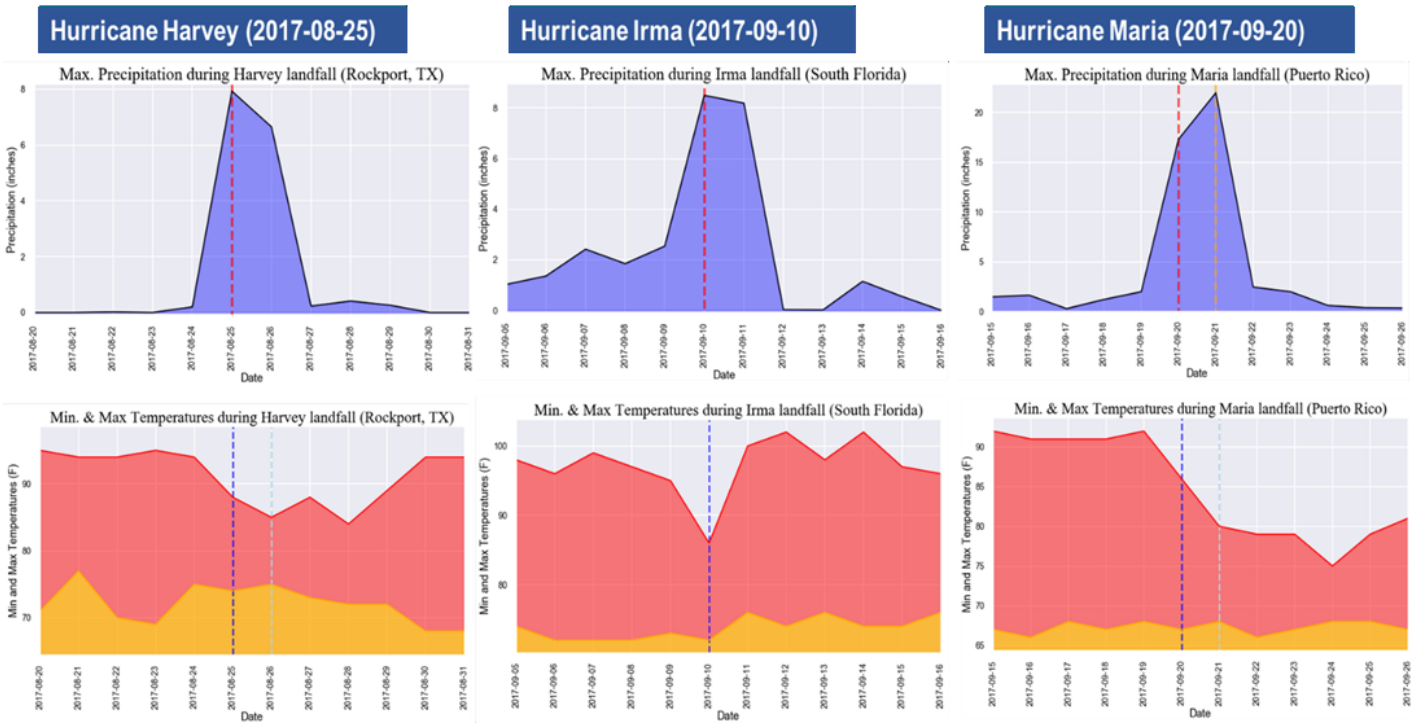
Question 3: Does a tropical storm effect the temperature on land?

Introduction:
Hurricanes are powered by warm ocean waters (typically above 80F, allowing water to evaporate and condense into clouds). The storm develops from there, but it's this "rising" motion that holds to key to nature's way of temperature regulation. The heat literally is lifted from the ocean, transferred to the upper atmosphere, and spread toward the poles. When a hurricane passes over the ocean, it absorbs energy from warm water – cooling the upper ocean. In late summer 2005, the extremely warm sea surface temperatures in the Gulf of Mexico fueled two powerful Hurricanes: Katrina and Rita. According to data from NASA's Tropical Rainfall Measuring Mission (TRMM) satellite, **each of these storms cooled water temperatures more than 4 degrees Celsius in places along their paths and cooled the entire Gulf by about 1 degree**. The Gulf was so warm, however, that water temperatures quickly rebounded, and remained high enough to support hurricanes until well into the middle of October. The cooling of the ocean is also caused by the upwelling of cold water from below due to the suction effect of the low-pressure center of the storm. Additional cooling may come from cold water from raindrops that remain on the ocean surface for a time. Cloud cover may also play a role in cooling the ocean by shielding the ocean surface from direct sunlight before and slightly after the storm passage. All these effects can combine to produce a **dramatic drop in sea surface temperature over a large area in just a few days**.

Problem Statement:
We know that hurricanes cool ocean water, but do they cool the land where they make landfall?

APIs used:
Metrological data was retrieved from the coastal weather stations near hurricane landfall using an API from NOAA (**National Oceanic and Atmospheric Administration**).

Results:
We studied the precipitation and temperature data from the landfall areas of 3 major hurricanes during 2017. Here is a data summary:



Each hurricane is accompanied by a **spike in precipitation** (blue) in the landfall areas.
Correspondingly, the **maximum air temperature (shown in red)** dropped when a hurricane made landfall.

Minimum air temperature (shown in yellow) increased for Harvey and Irma but remained unchanged for Maria.
Maximum temperature **rebounded fastest** in the South Florida coast (Hurricane Irma) and remained low in Puerto Rico (Hurricane Maria) for the longest time. This is probably an indication how long hurricane clouds lingered over the landmass.

Conclusion:

Our study indicates **hurricanes have a "cooling effect" on earth**. Hurricanes are supported by both primary and secondary circulations; primary circulation is what we see in the satellite photos showing clouds whirling around the eye of the storm. The secondary circulation is a vast heat engine that provides the energy needed to support the primary circulation. All weather is caused by imbalances and mother nature's method of managing heat imbalance in the oceans is creating hurricanes – a giant blender that mixes the hot, humid surface air at the center with the dry colder air at the top of the troposphere. This cold air from top falls in downward drafts at the outer edges of the storm cooling the landmass.
Added to this phenomenon, the clouds prevent sunlight and its heating energy from reaching the ground. Combination of these two effects, depress the maximum temperature as seen in our study.
Along with cooling the oceans, hurricanes do cool the landmass where they make landfall.