HurriPy: Question # 3

Introduction

I was a part of a group of data scientists who took upon themselves to analyze the correlations between cyclones and impacting factors. Our analysis was presented as a project to the Data Analysis & Visualization Boot Camp – McCombs School of Business, University of Texas at Austin. The complete project is available at:

https://github.com/TheGreekGoddess/Project_HurriPy

While my teammates worked on different impacting factors and demographic changes after a hurricane makes a landfall, I was intrigued by the possibility that hurricanes can produce a cooling effect on land.

Background

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. 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. Cooling of the ocean is also caused by 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:

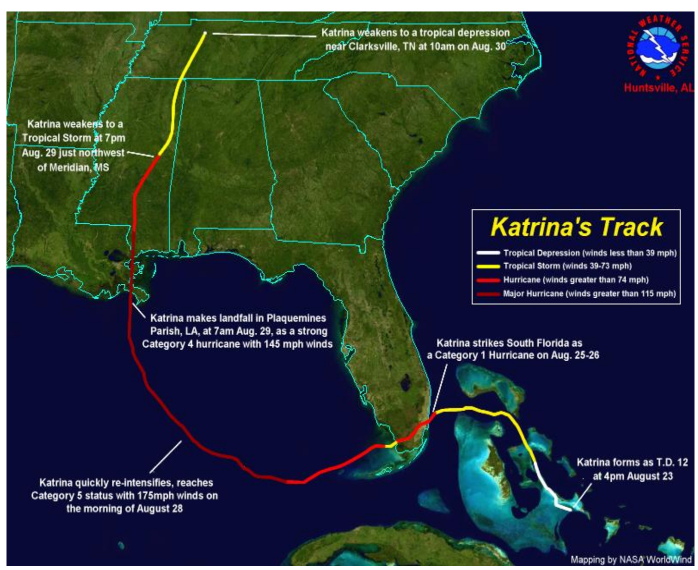
Does a hurricane cool the land where they make landfall?

APIs used:

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

Hurricane Katrina:

Figure 1. Tract of Hurricane Katrina



Hurricane Katrina the costliest storm in U.S. history, made landfall off the coast of Louisiana on August 29, 2005. An estimated 1,833 people died in the hurricane and the flooding that followed in late August 2005, and millions of others were left homeless along the Gulf Coast and in New Orleans. Katrina was the most destructive storm to strike the United States and the costliest storm in U.S. history, causing 108 billion dollars in damage. It ranks sixth overall in strength of recorded Atlantic hurricanes.

Katrina first formed as a tropical depression in Caribbean waters near the Bahamas on August 23, 2005.

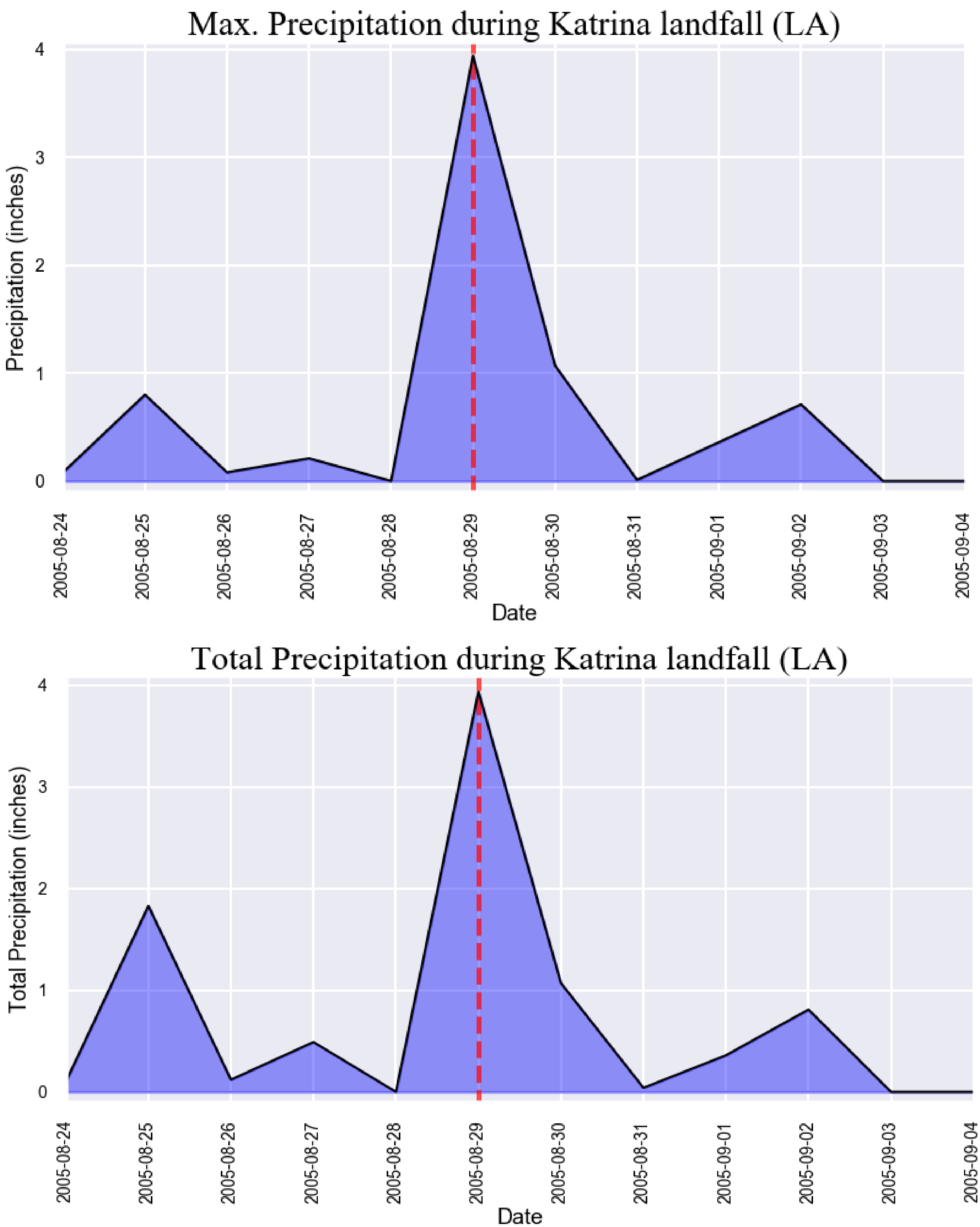


Figure 2. Maximum and Total Precipitation during Katrina

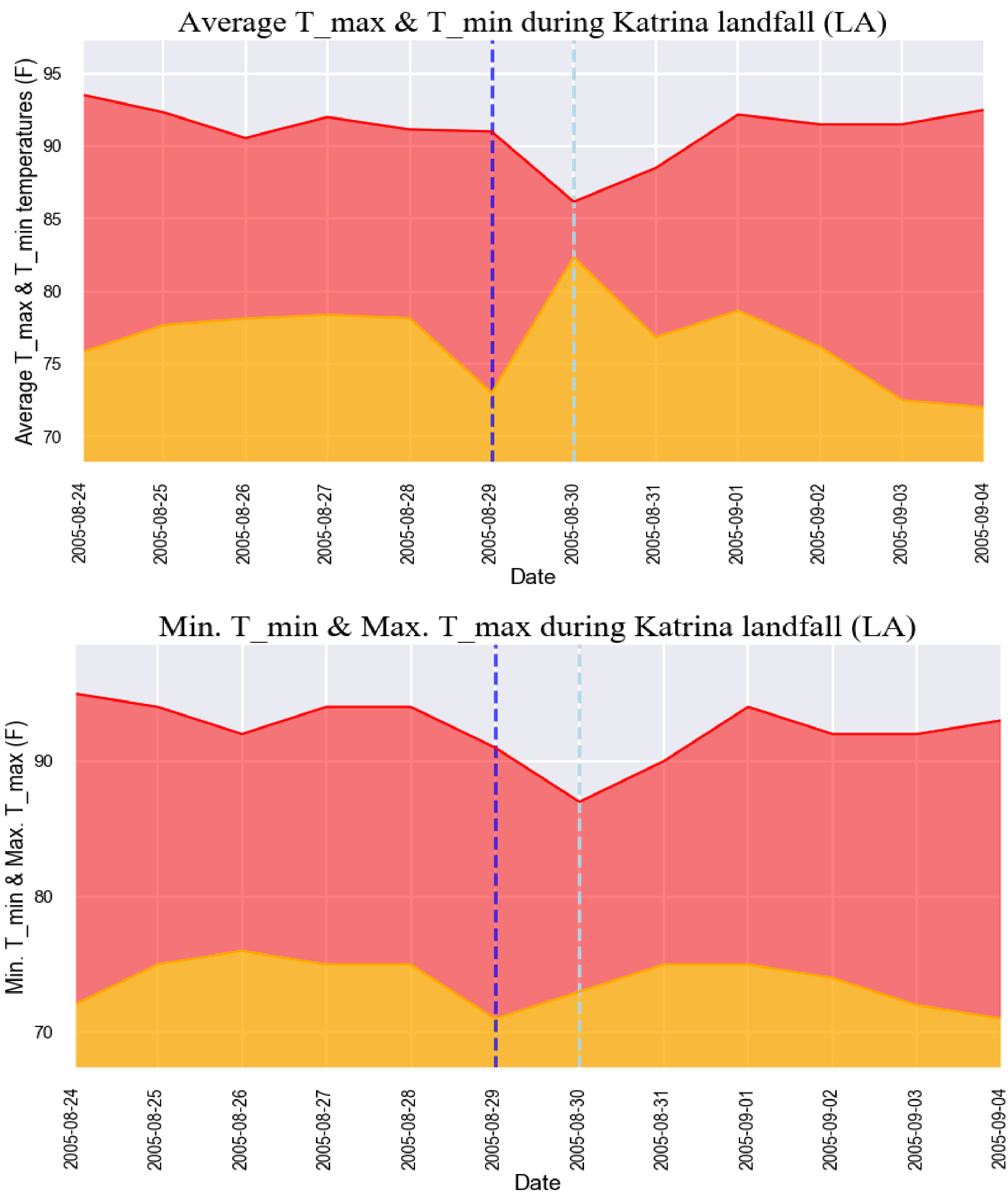
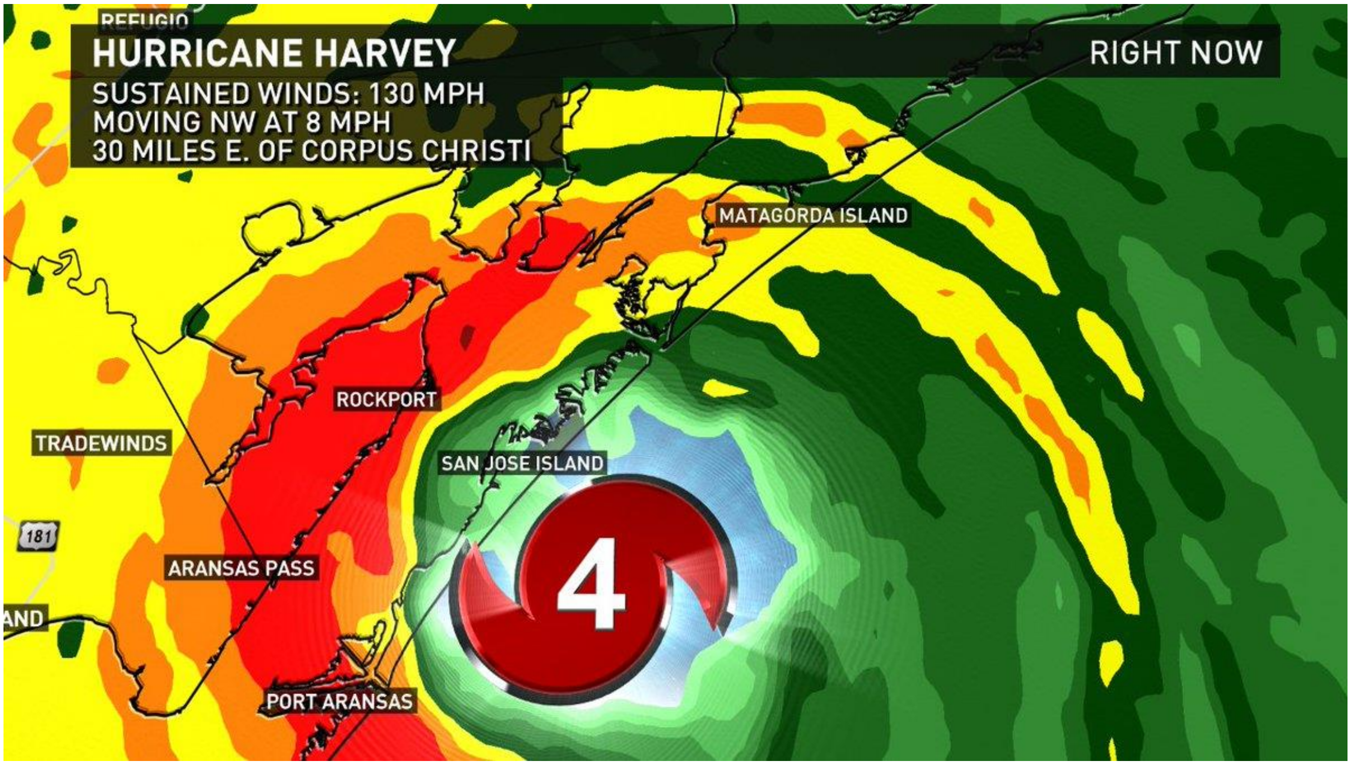


Figure 3. Average and extreme minimum and maximum temperatures during Katrina

Hurricane Harvey:



Hurricane Harvey, Category 4 hurricane, first major hurricane to make land-fall in US since Wilma in 2005

Harvey made landfall at San Jose island, Texas at peak intensity on August 26,2017 followed by second landfall Holiday Beach (Category 3)**.**Harvey turned into tropical storm and emerged from Gulf of Mexico with 5th and final landfall in Louisiana on August 29. 300,000 structures, 500,000 vehicles damaged or de-stroyed, 125billion dollar loss. Costliest tropical storm alongside Katrina***.***

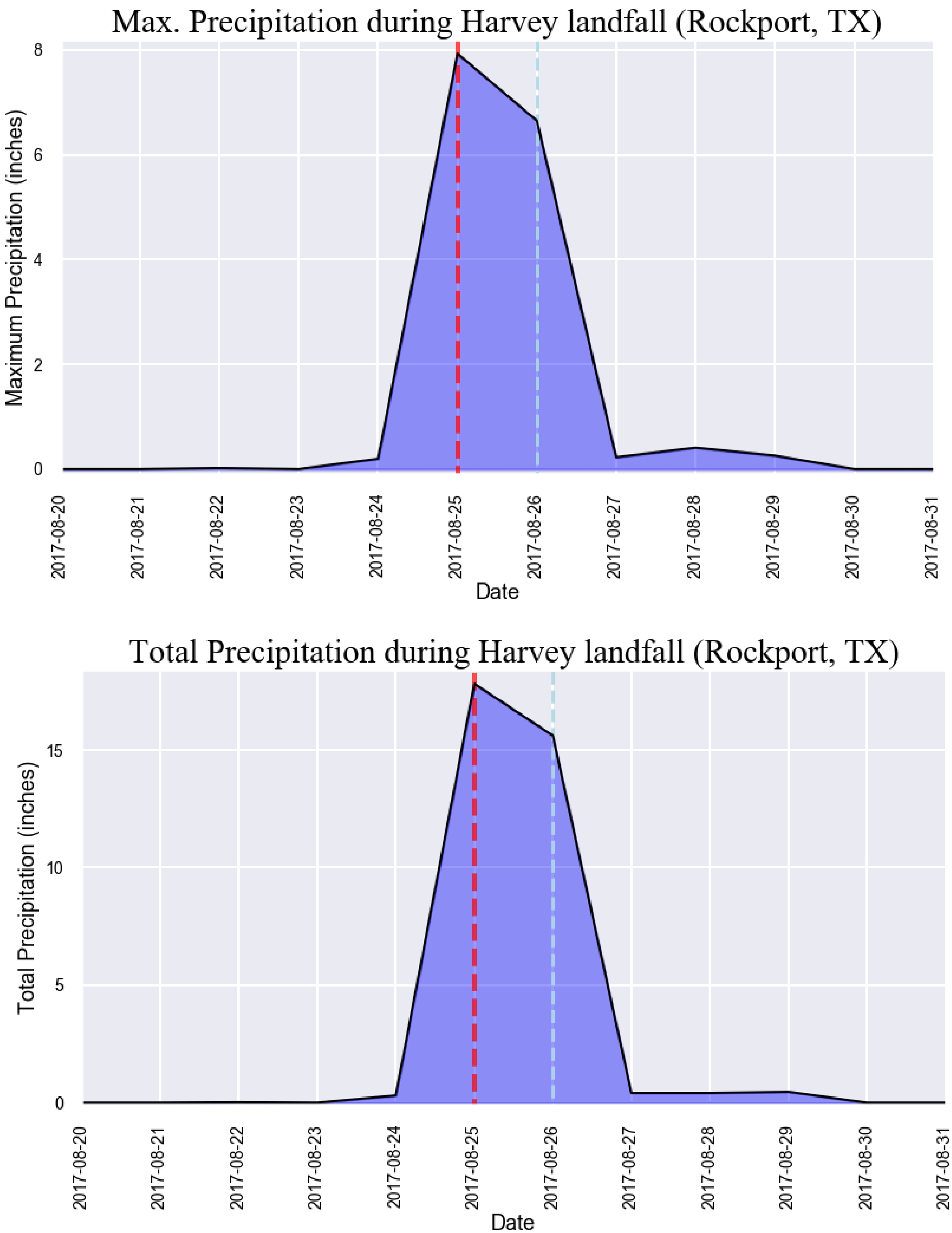


Figure 4. Maximum and Total Precipitation during Harvey

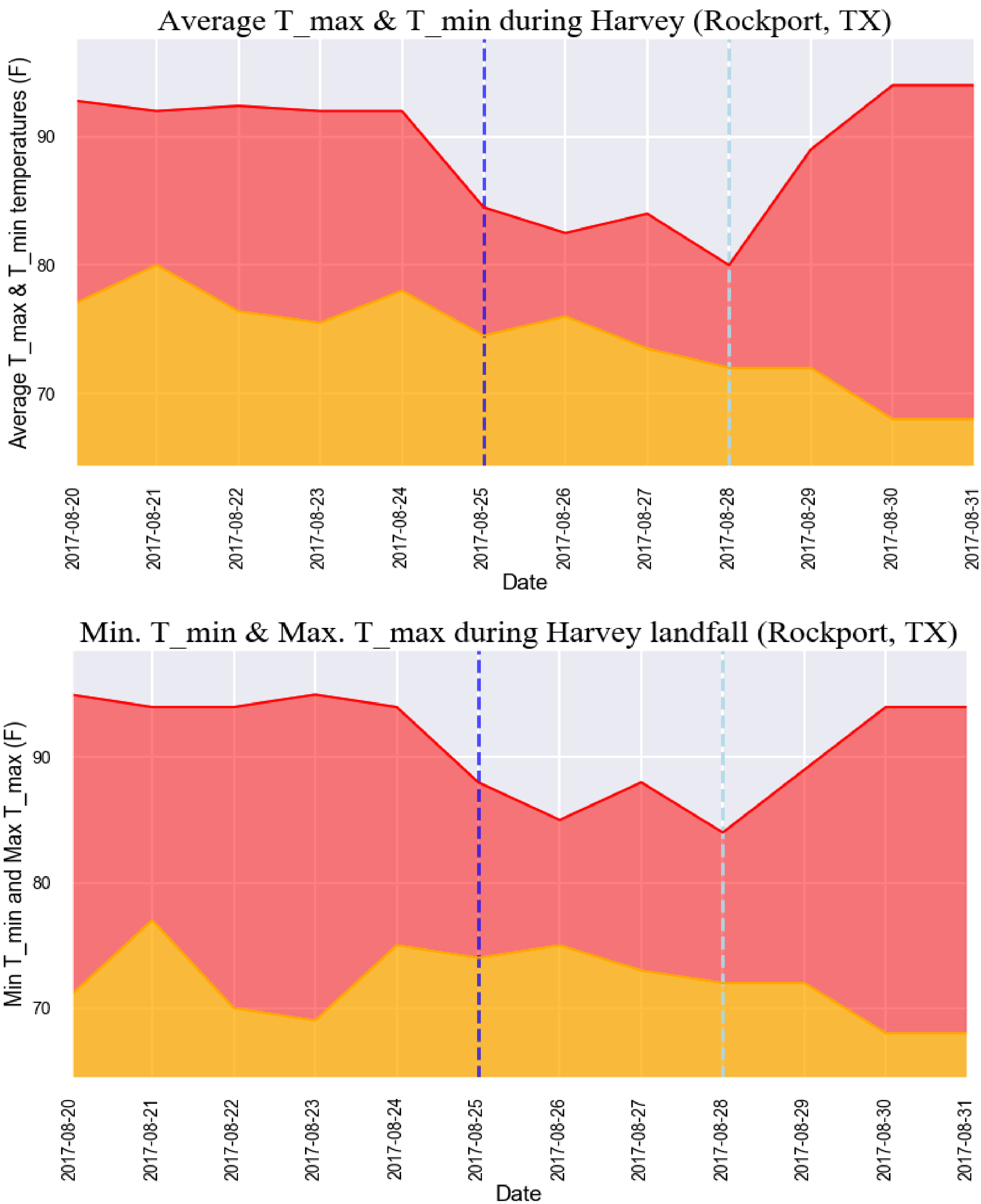
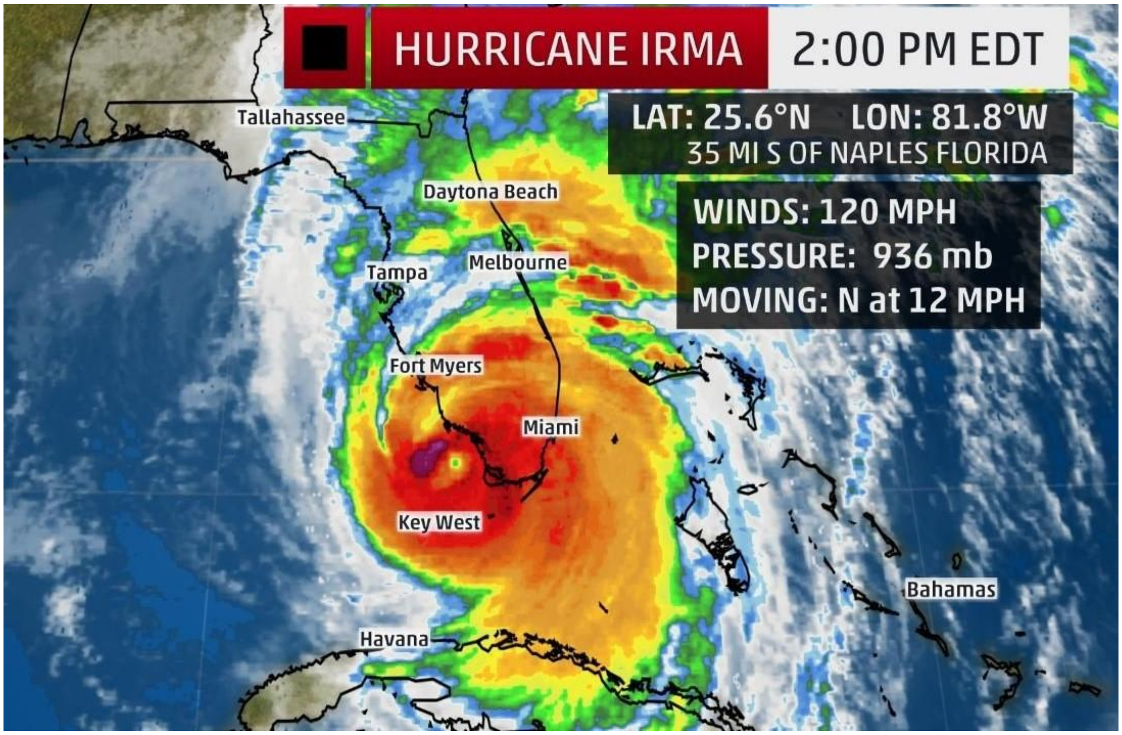


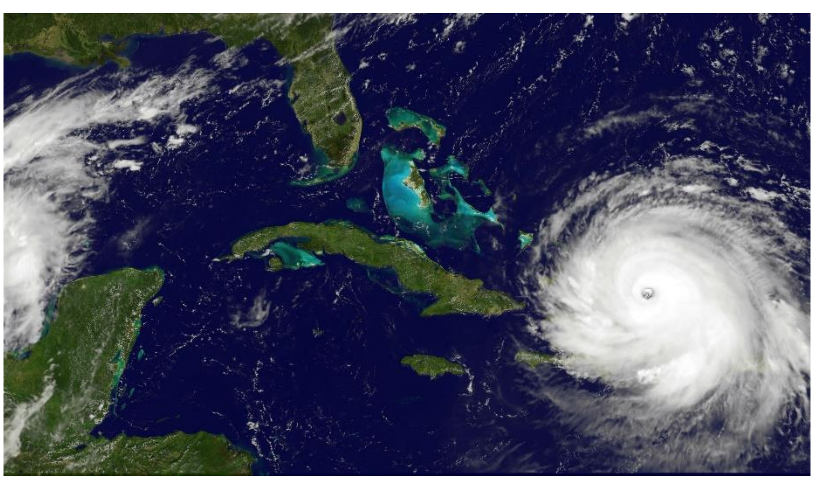
Figure 5. Average and extreme maximum and minimum temperatures during Harvey

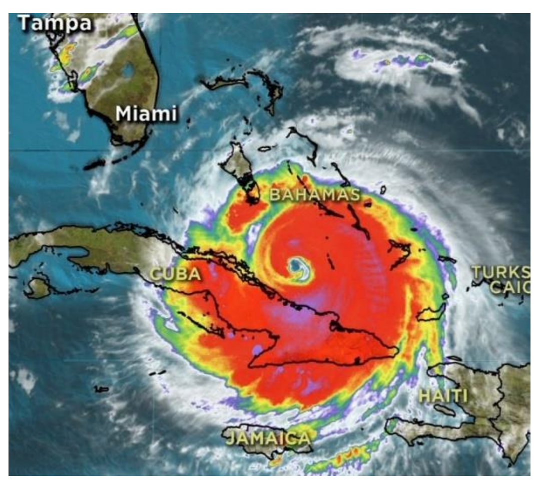
Hurricane Irma:

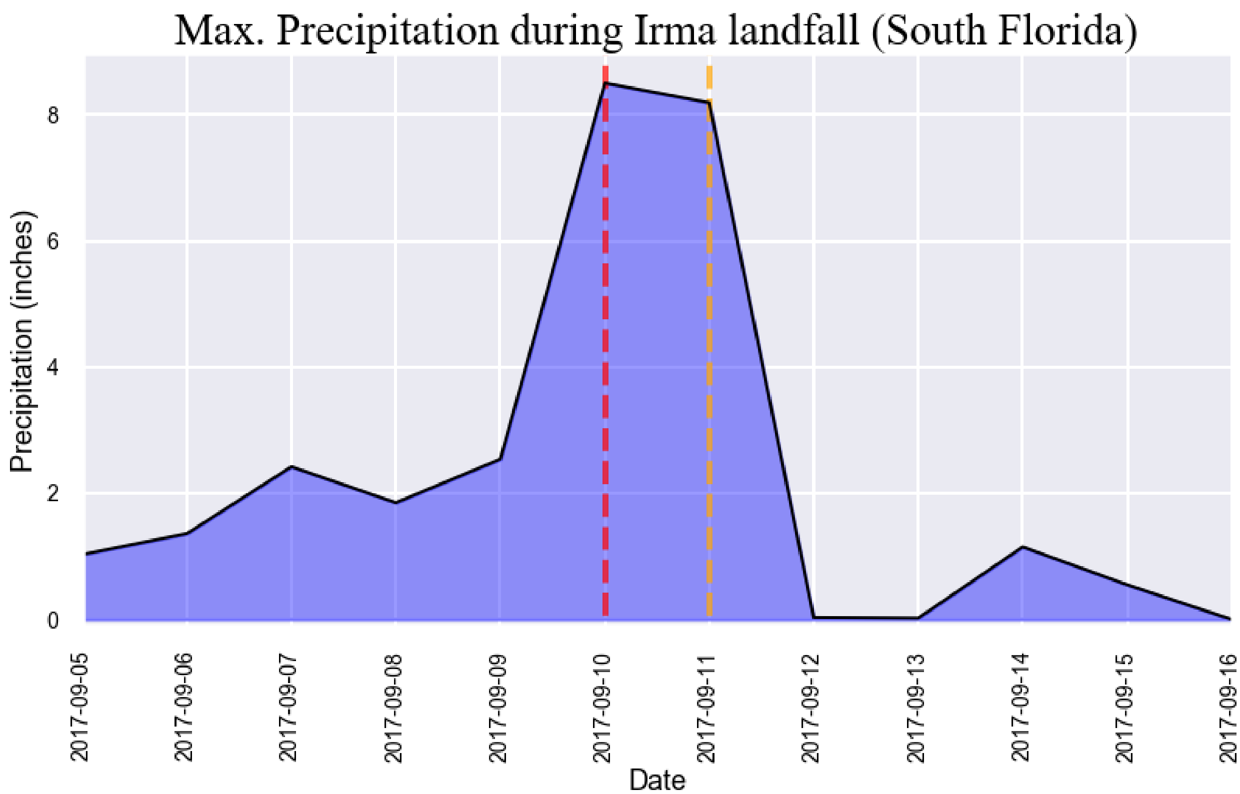


Irma was the second-most intense tropical cyclone worldwide in 2017 in terms of barometric pressure, and the strongest worldwide in 2017 in terms of wind speed.

Hurricane Irma made landfall over the southern Florida mainland around 1 p.m. local time Sunday, Sept. 10 as a Category 3 storm, packing winds of more than 110 miles per hour. It was also the most intense hurricane to strike the continental United States since Katrina, first Category 5 hurricane of the 2017 season, Irma caused widespread and catastrophic damage throughout its long lifetime, particularly in the northeastern Caribbean and the Florida Keys. The word ***Irmageddon*** was coined soon after the hurricane to describe the damage caused by the hurricane.







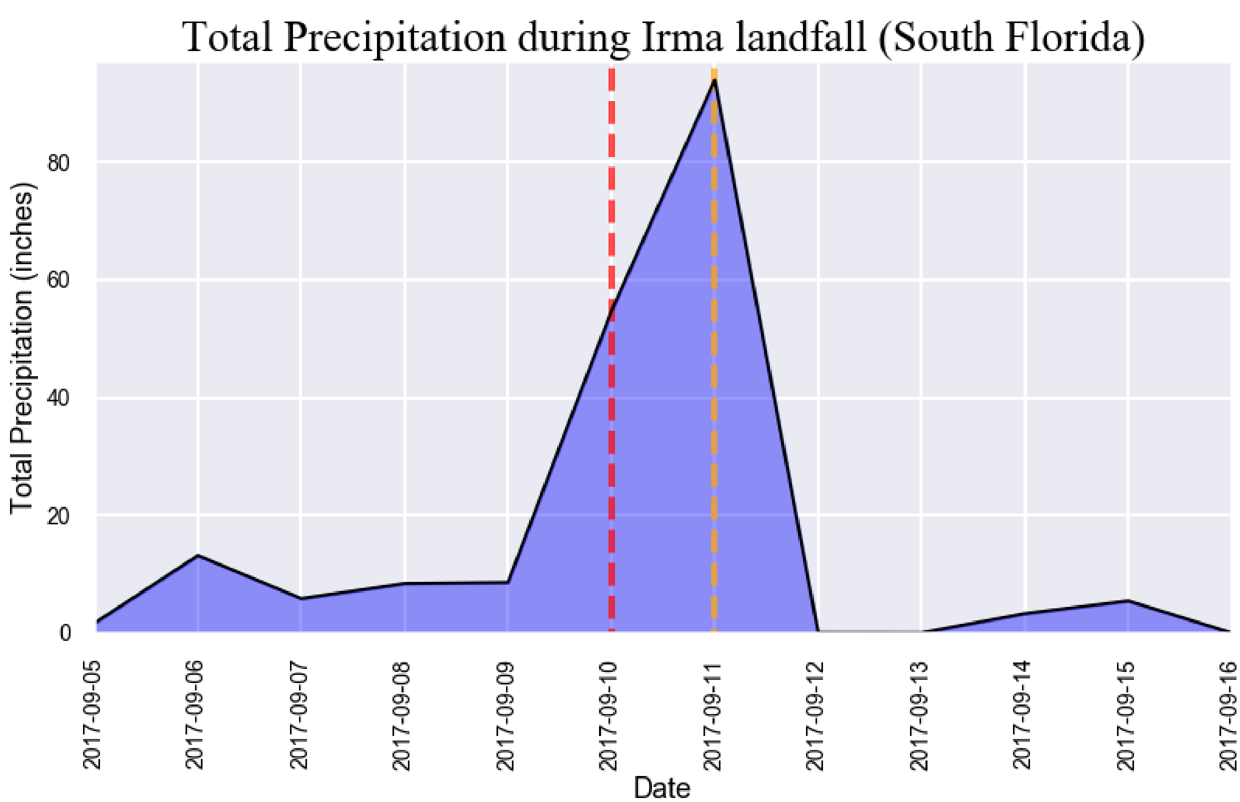


Figure 6. Maximum and Total Precipitation during Irma

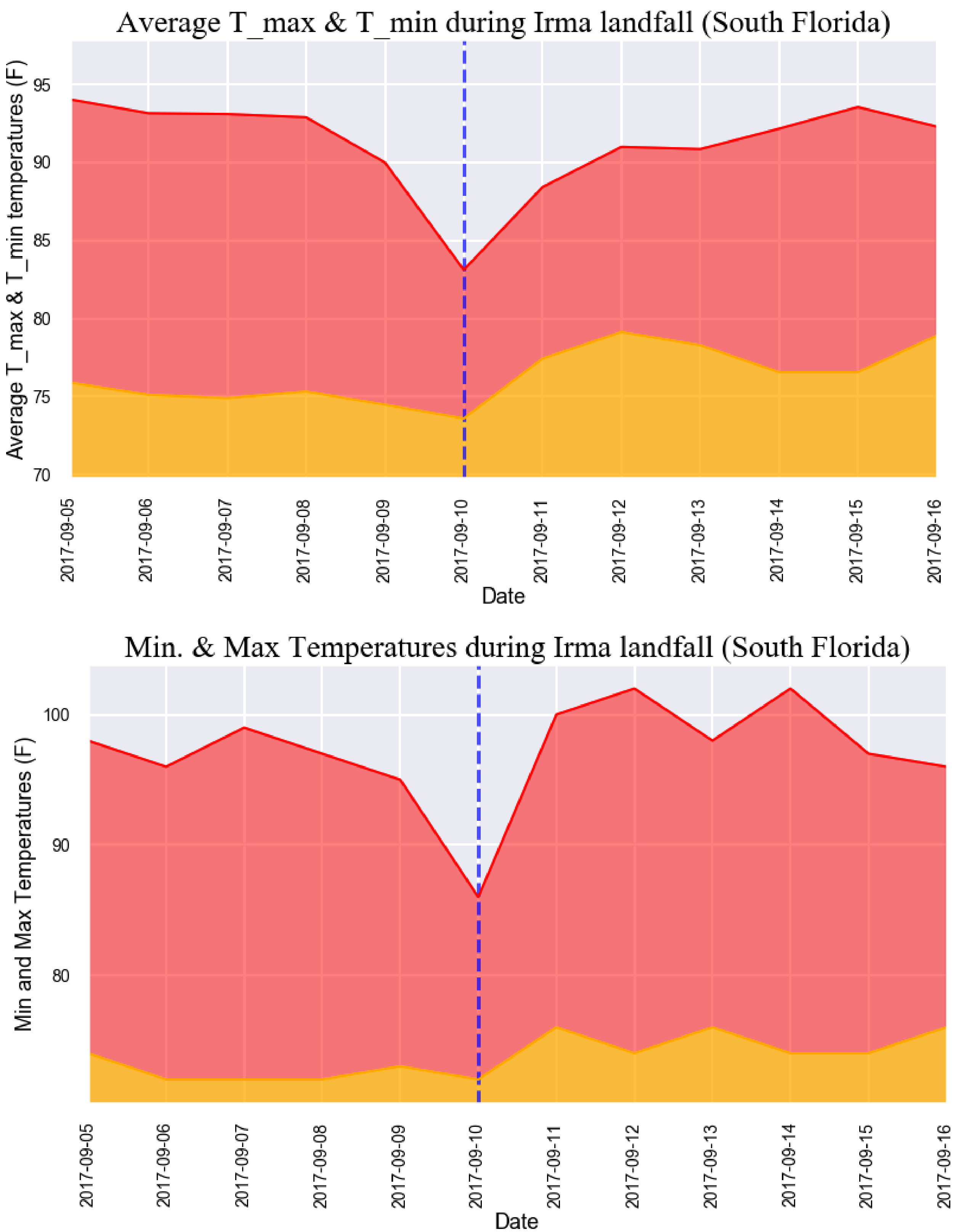
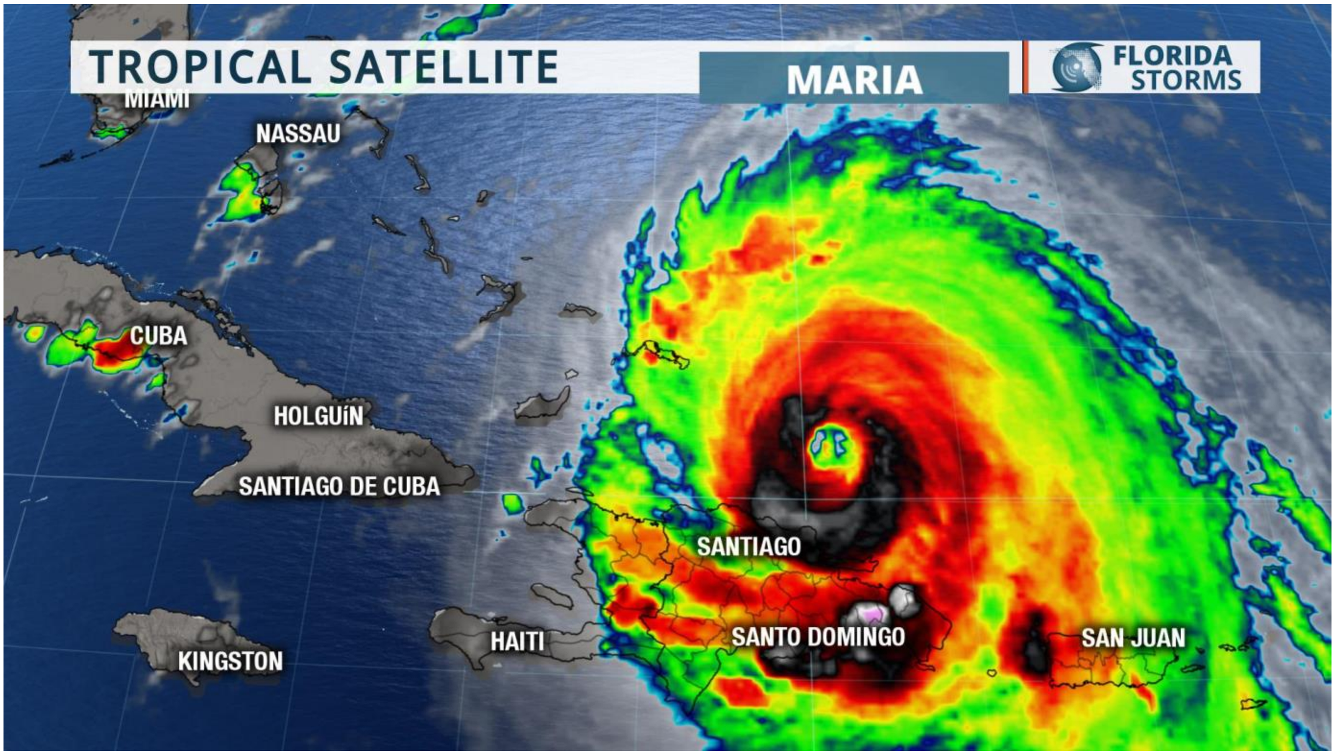


Figure 7. Average and extreme maximum and minimum temperatures during Irma

Hurricane Maria:



Hurricane Maria was a deadly Category 5 hurricane that devastated Dominica, St Croix, and Puerto Rico in September 2017

Worst natural disaster in recorded history to affect those islands and was also the deadliest Atlantic hurricane since Jeanne in 2004. The tenth-most intense Atlantic hurricane on record and the most intense tropical cyclone worldwide in 2017.The hurricane reached Category 5 strength on September 18 just before making landfall in Dominica, becoming the first Category 5 hurricane on record to strike the island. On September 20, an eyewall replacement cycle took place, weakening Maria to a high-end Category 4 hurricane by the time it struck Puerto Rico. On August 28, 2018 (almost a year after the hurricane), Puerto Rico revised its official tally of 64 killed in the hurricane up to 2,975, making the total death toll 3,059.

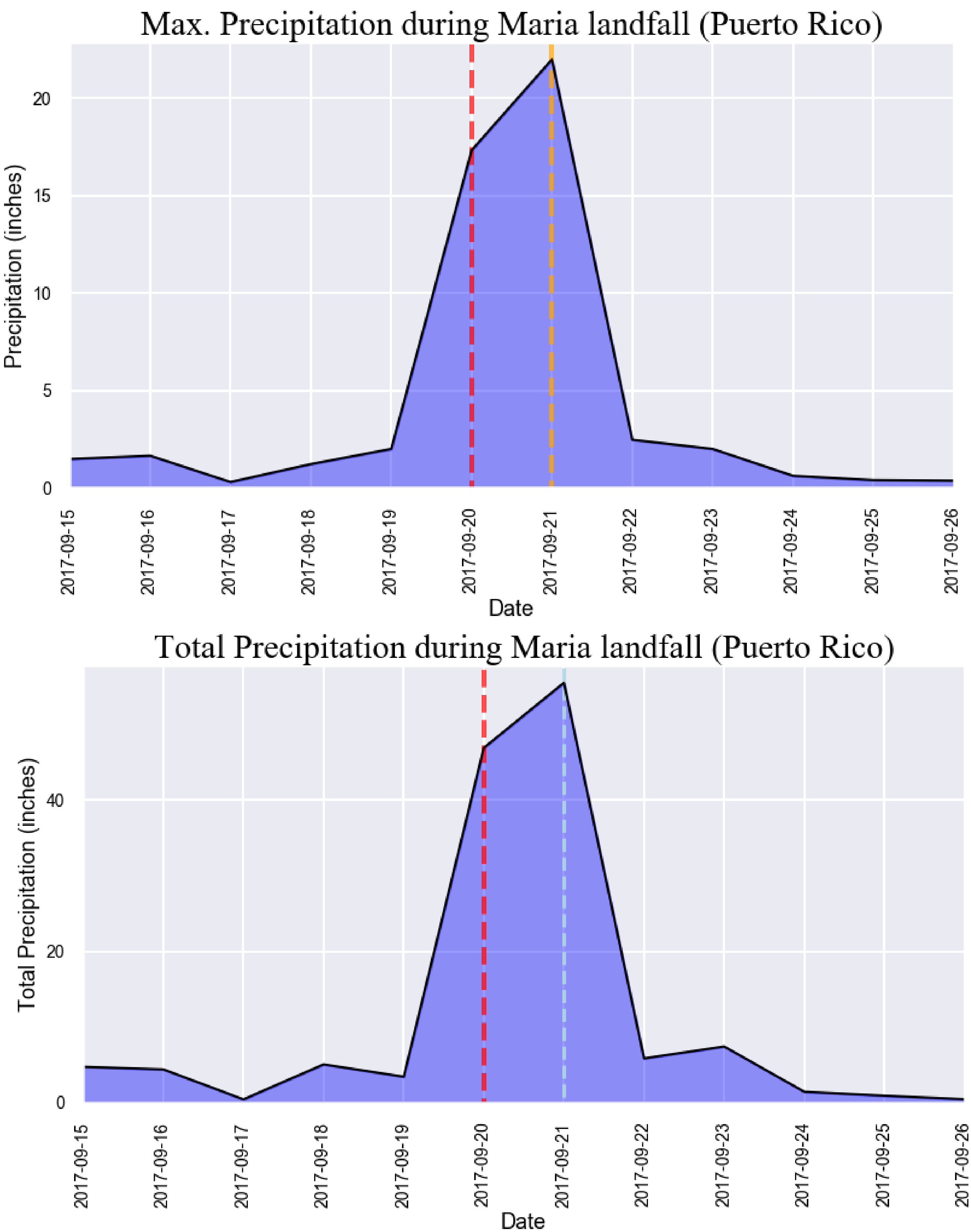


Figure 8. Maximum and Total Precipitation during Maria

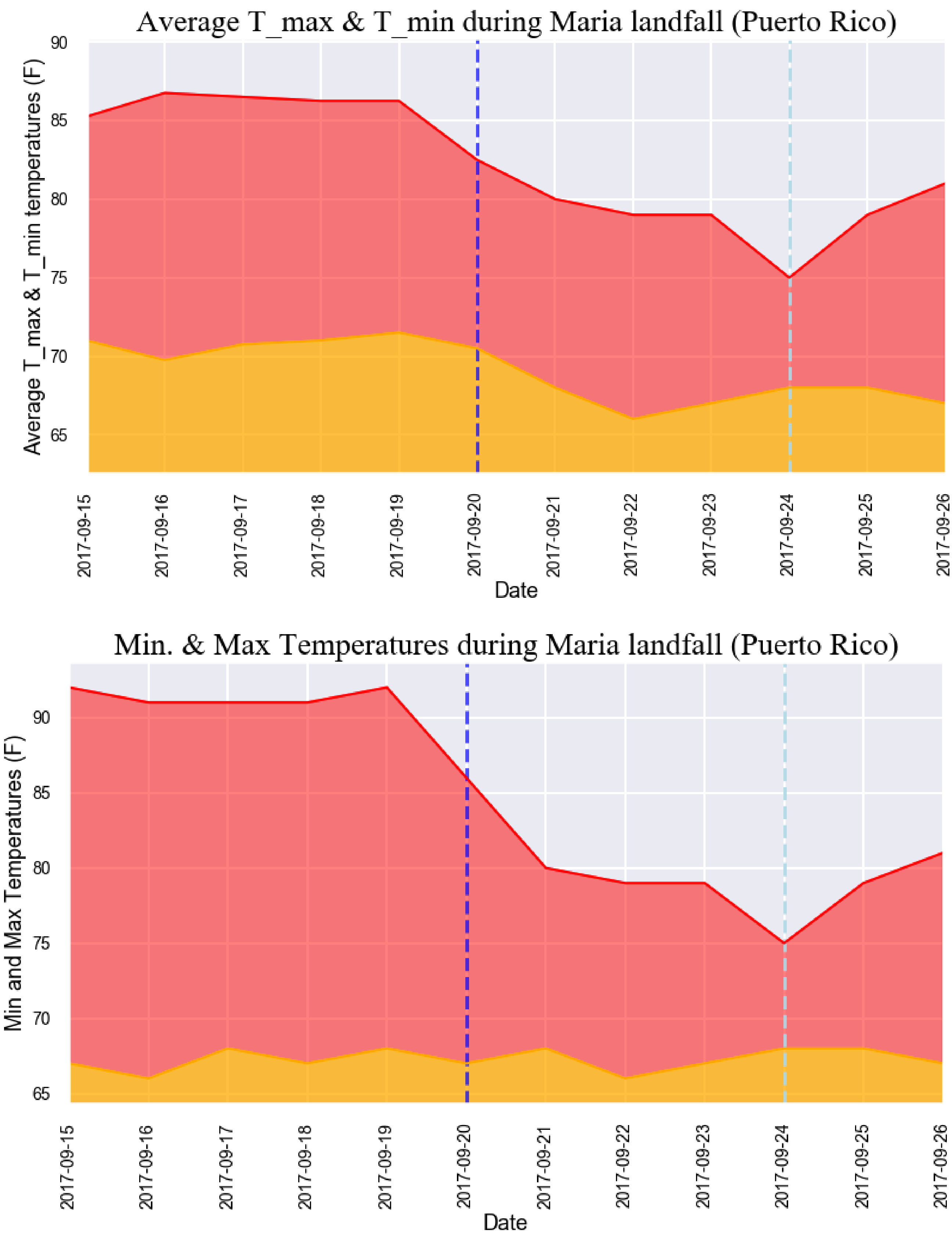


Figure 9. Average and extreme maximum and minimum temperatures during Maria

Results: We studied the precipitation and temperature data from the landfall areas of 4 major hurricanes – Katrina, Harvey, Irma and Maria. 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 a landfall.

In most cases the drop continued over few days after landfall probably indicating the duration of cloud cover 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 cool the landmass where they make landfall.