Response and Recovery of Sea Surface Temperature Near Puerto Rico to Hurricanes Irma and Maria, September 2017

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Introduction

In September 2017 Puerto Rico suffered the passage of two major hurricanes, Irma and Maria. Both were Category 5 hurricanes at some point, however at landfall (Maria) and point of closest approach (Irma) they were Category 4 intensity. The purpose of this study is to examine the response/recovery of regional sea surface temperature (SST) associated with the two hurricanes.

The eye of Hurricane Irma tracked 50n mi to the North of Puerto Rico on September 6-7, 2017. The strongest winds reported on the island occurred at La Puntilla, in San Juan Bay. Winds were sustained at 48 kts with a gust to 64 kts.

Hurricane Maria made landfall at Yabucoa, Puerto Rico on September 20, 2017 at 1015 UTC. At landfall, in the south east, Hurricane Maria had wind speeds of 135 kt. and an eye diameter of 28 n mi. At 1800 UTC, in the north west, Maria emerged to the Atlantic Ocean with winds of 95kt.

Materials and Methods

SST data for each hurricane were obtained from the National Data Buoy Center (NDBC) website. After looking through the data we chose 6 buoys that had the best data available for SST. Five National Ocean Service (NOS) water level stations (MISP4, MGIP4, SJNP4, ESPP4, and CLBP4) around the island and one Caribbean Regional Association for Coastal Ocean Observing (CARICOOS) ocean buoy (41115) provided continuous SST for the hurricane period. Python in a Google Collab environment was used to do the coding and make the graphs.
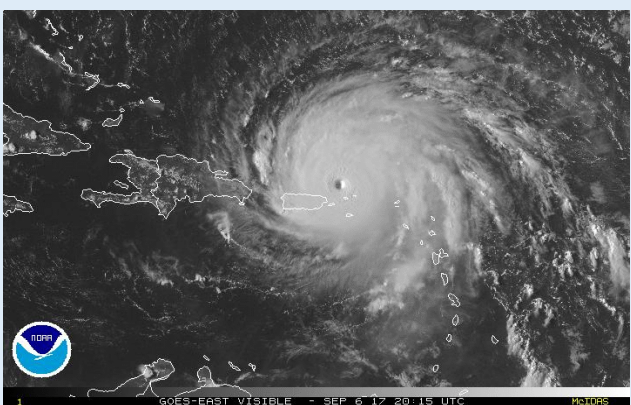
**Figure 1.** Hurricane Irma 50n mi of Puerto Rico. Image taken from: https://www.ospo.noaa.gov/Organization/History/imagery/Irma/index.html
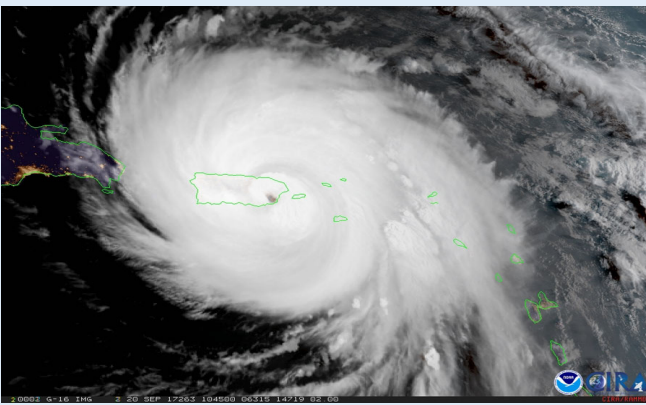
Figure 2. GOES-16 image of Hurricane Maria above Puerto Rico on its landfall on September 20, 2017. Image taken from: https://www.goes-r.gov/mission/hurricaneMaria.html


Figure 3. Map showing stations used in analysis and trajectories of Hurricanes Irma and Maria.

Results

- Response
  - The SST had an average decrease of 2.2°C after Hurricane Irma.
  - The SST had an average decrease of 2.3 °C after Hurricane Maria.

- Recovery time to recover one-half of the decreased SST.
  - For Hurricane Irma, it took between 1-3 days.
  - For Hurricane Maria, it took between 2-7 days.
  - Although for Hurricane Maria the recovery of SST for each buoy wasn't available because of data loss.

- Heat Loss
  - Hurricane Irma had a heat loss from 228 – 685 Wm^{-2}.
 - Hurricane Maria had a heat loss from 388 - 1370 Wm^{-2}.
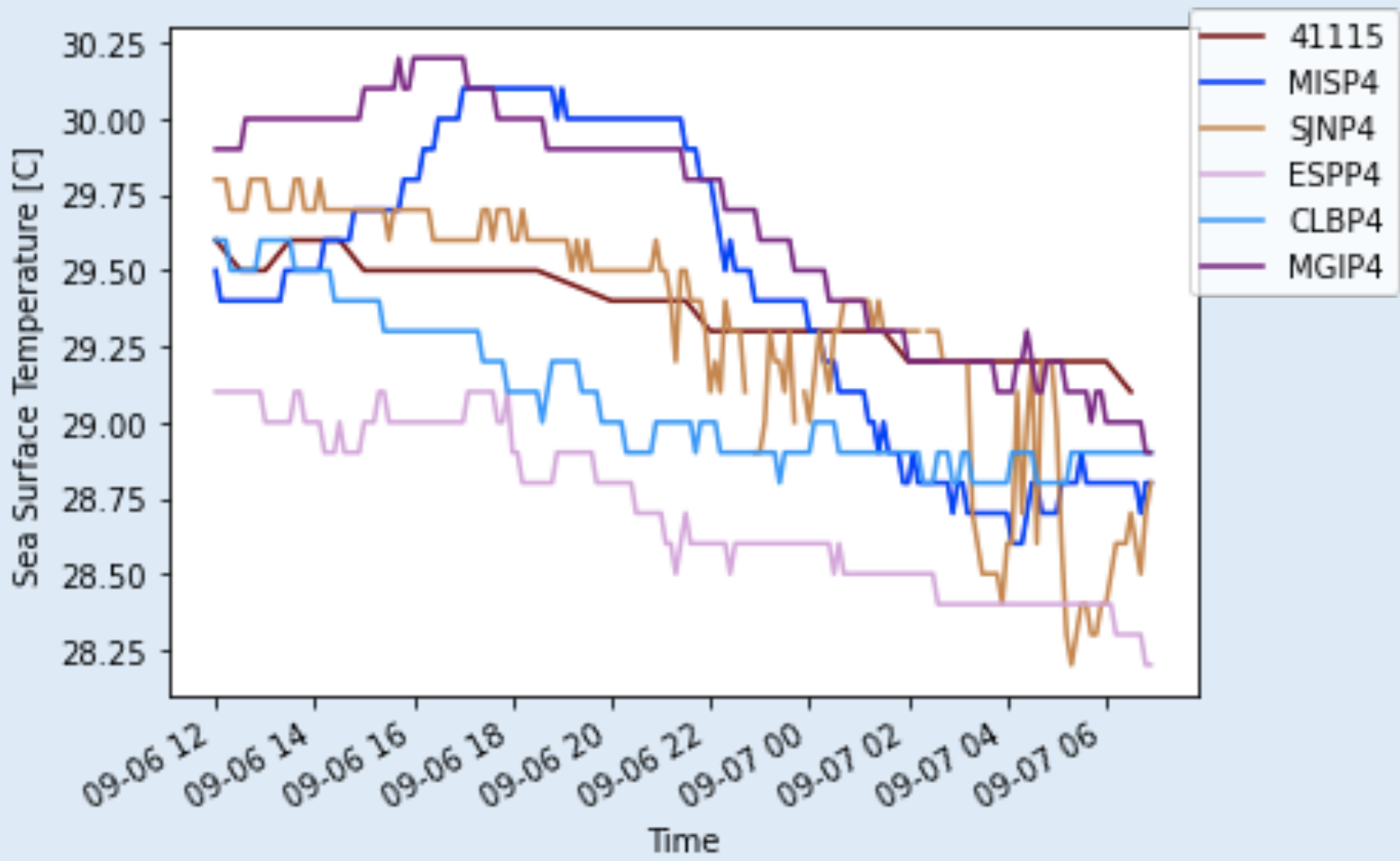
Figure 4. Hurricane Irma trajectory sea surface temperature. An average decrease of 2 ºC can be visible in this graph.
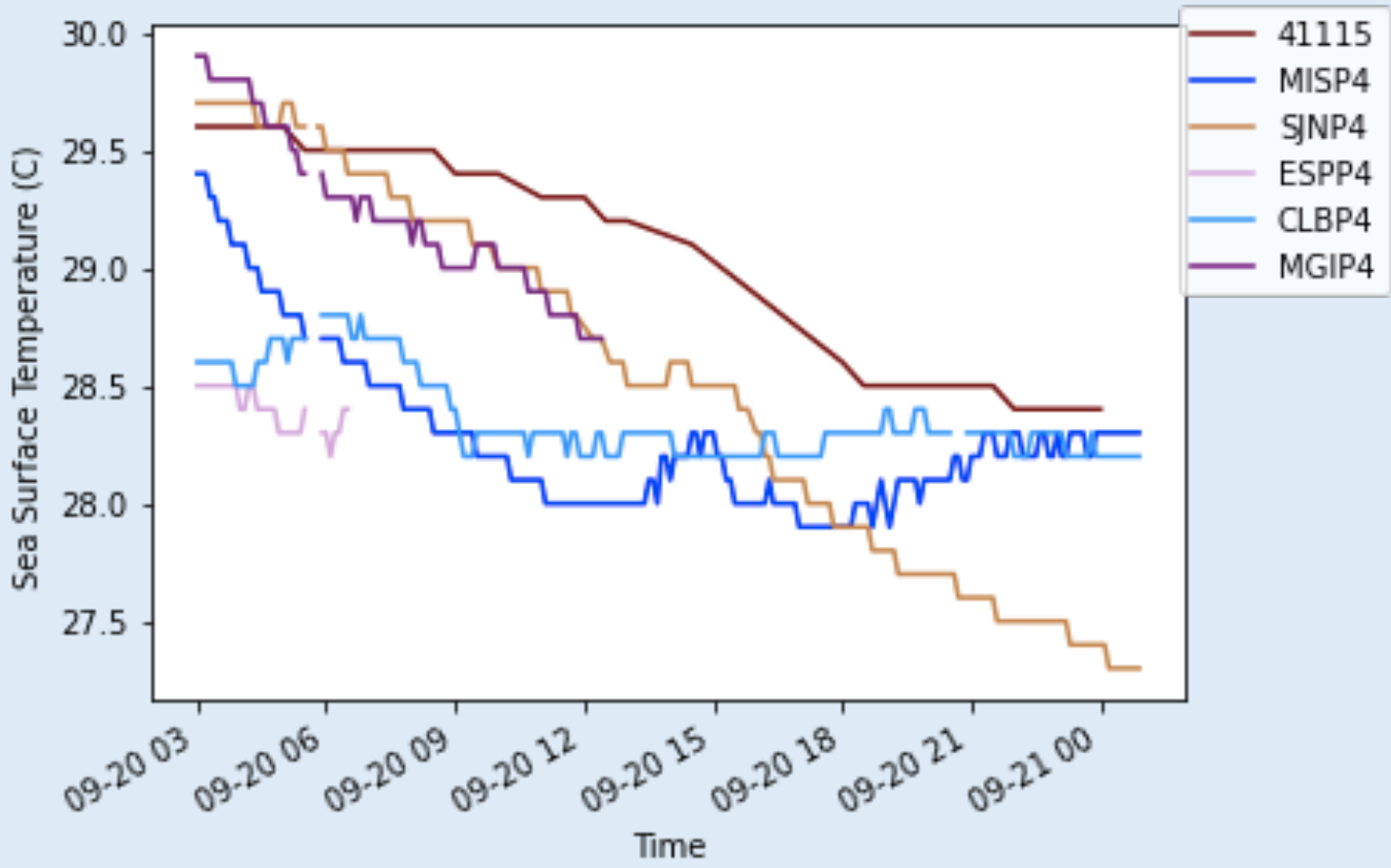
Figure 5. Hurricane Maria trajectory sea surface temperature. An average decrease of 2 ºC can be visible in this graph.
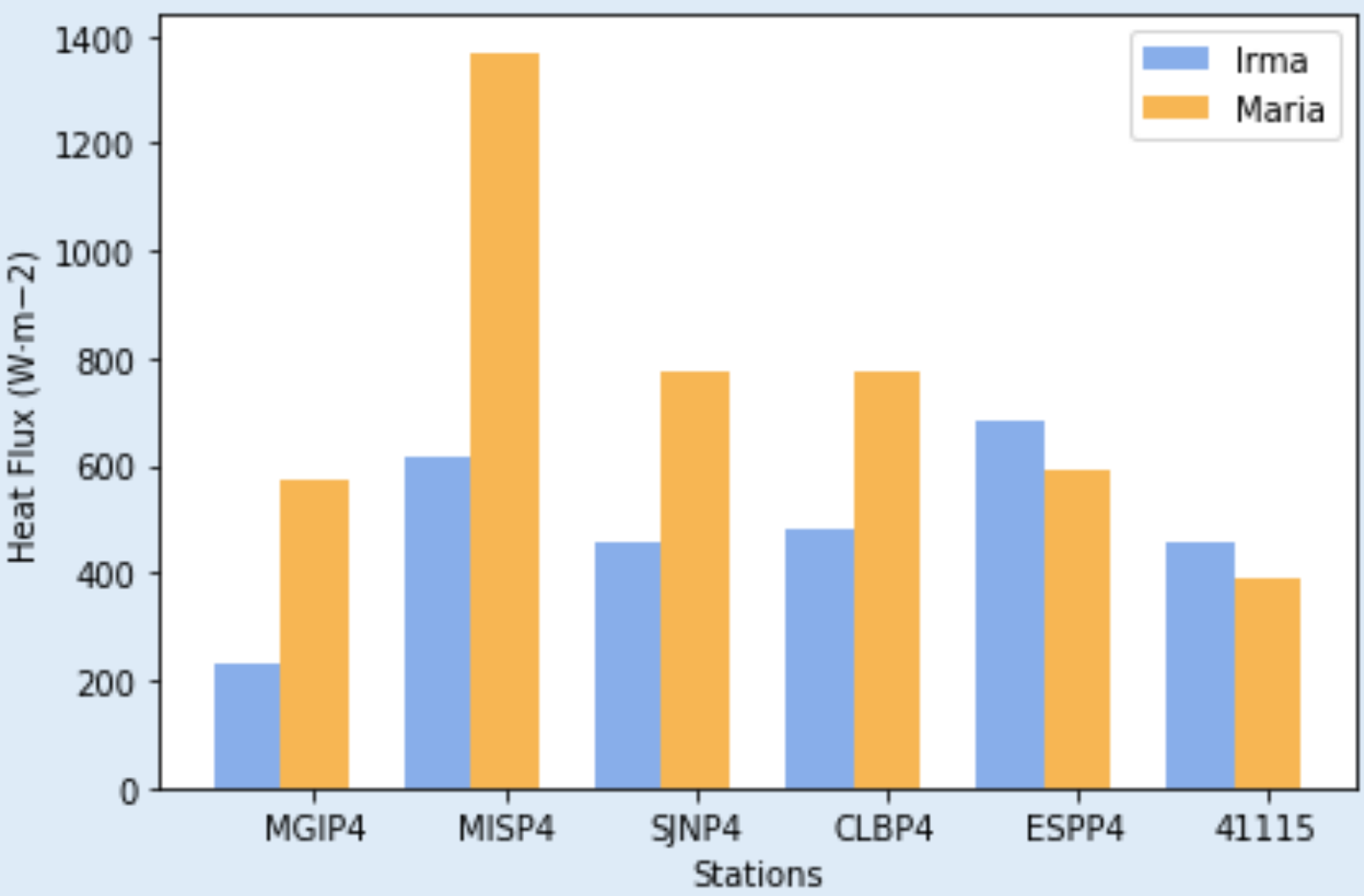
Figure 6. Heat Transfer to the atmosphere for the passage of Hurricane Irma and Maria.
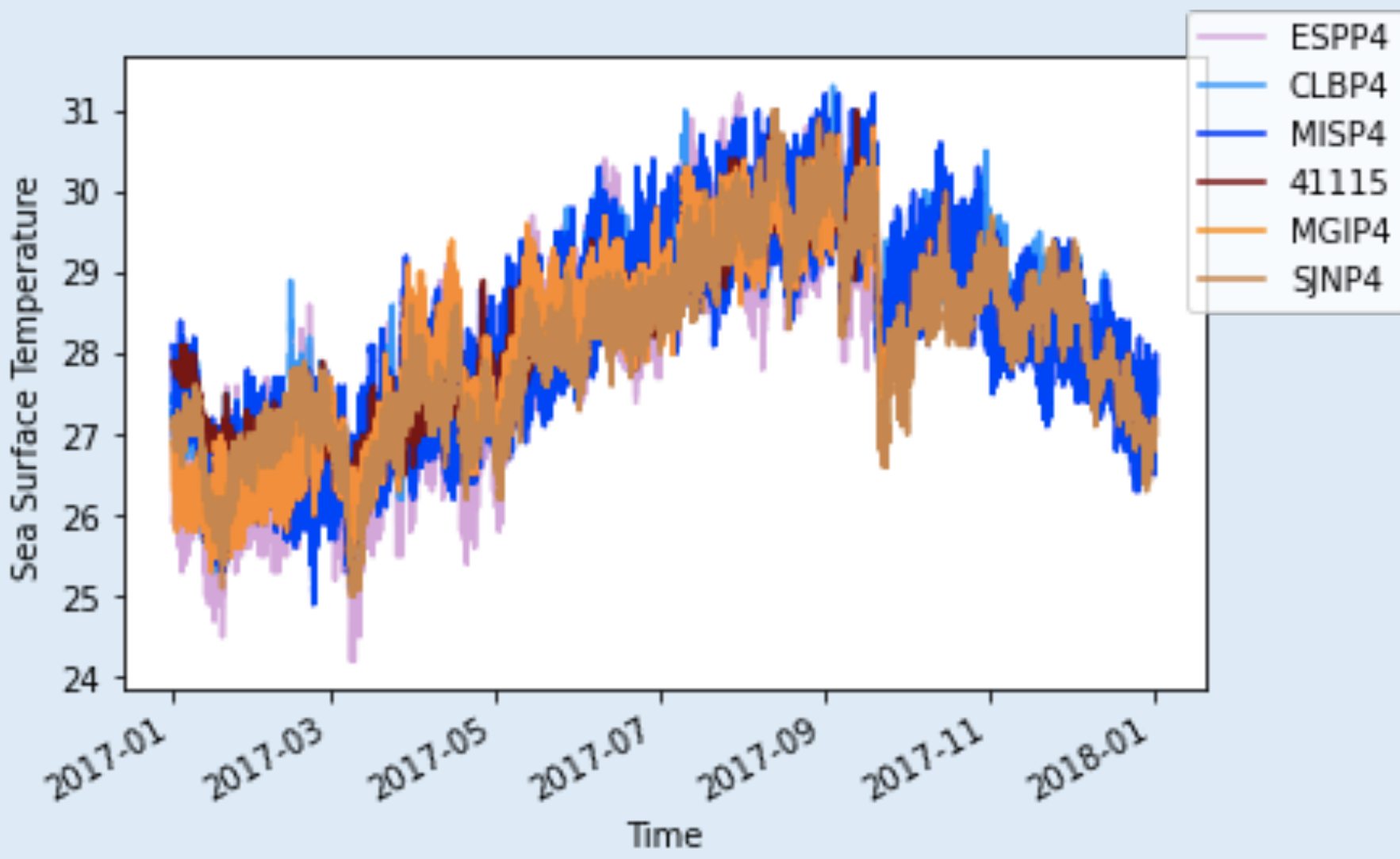
Figure 7. Sea surface temperature for the seasonal cycle of 2017. A decrease in temperature after Hurricane Irma and Maria is visible in this graph.

Conclusions

Hurricane Irma and Maria not only had an impact on land, but also to the coastline of Puerto Rico. The SST can be a portrayal of the changes during and after their passage.

Factors like Hurricane Maria passing over Puerto Rico made the SST recover slower than for Hurricane Irma. Meaning that the areas around the stations were mostly affected by Maria than by Irma. Overall the response of SST for both hurricanes was similar. Although the recovery for both hurricanes was different therefore a conclusion on the recovery is complicated to determine because of seasonal cooling and data loss. Most of the data loss happened after Hurricane Maria, however sssfor Irma it also happened.

Higher values of heat loss occurred during the passage of Hurricane Maria. The heat loss values indicate that some upwelling in the deeper water occurred. The northern stations had more heat loss than the southern station at the passage of Hurricane Irma. For Hurricane Maria, the station MISP4 had the largest heat loss.

Hurricane Irma and Maria had similar behaviors as Hurricane Harvey. Hurricane Harvey also happened that same year. Although it develop in the Gulf of Mexico.

Therefore, the upwelling, seasonal cooling, trajectory, the size, and intensity of both hurricanes affected the response and recovery of SST.

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