The Impacts of Hurricane Patricia on Sea Surface Temperature

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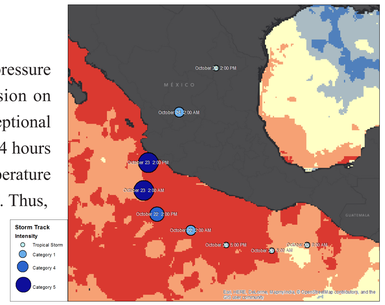
Introduction

Hurricane Patricia is the strongest tropical cyclone ever recorded in the Western Hemisphere in terms of barometric pressure and the strongest globally in terms of maximum sustained winds. Patricia was first identified as a tropical depression on October 20, 2015. The initial development was slow so, but soon became a tropical storm and was named Patricia. Exceptional environmental factors caused the storm to intensify and it grew from a tropical storm to a Category 5 hurricane in only 24 hours – a near-record pace. One of the environmental factors that fueled this dramatic transformation was the sea surface temperature (SST). SST at around 30 degree Celsius, or 86 degree Fahrenheit, is one of the boosting factors in hurricane dynamics[1]. Thus, SST is an important indicator in hurricane forecasting and the data are usually obtained by satellite images. We want to find if the SST of the waters off the western coast of Mexico contributed to the formation and intensification of the strongest storm on record.



Data

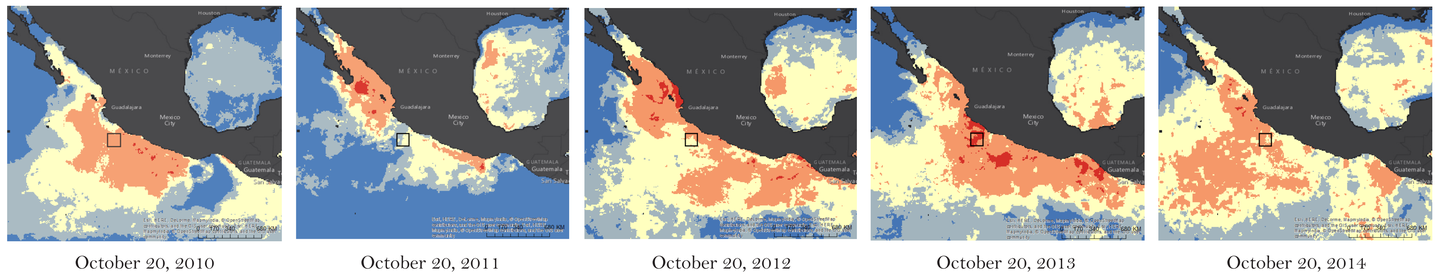
We used data optimally interpolated (OI) SST daily products obtained by satellite microwave and infrared radiometers from the Special Sensor Microwave Imager (SSMI) at a 9km resolution[2] from the date of October 20th during the years of 2010 through 2015. We also used the SSMI imagery from one and two weeks prior and one and two weeks after the formation of the storm. We also used storm track data for Hurricane Patricia from the National Hurricane Center (NHC) which is part of the National Oceanic and Atmospheric Administration (NOAA)[3].

Methodology

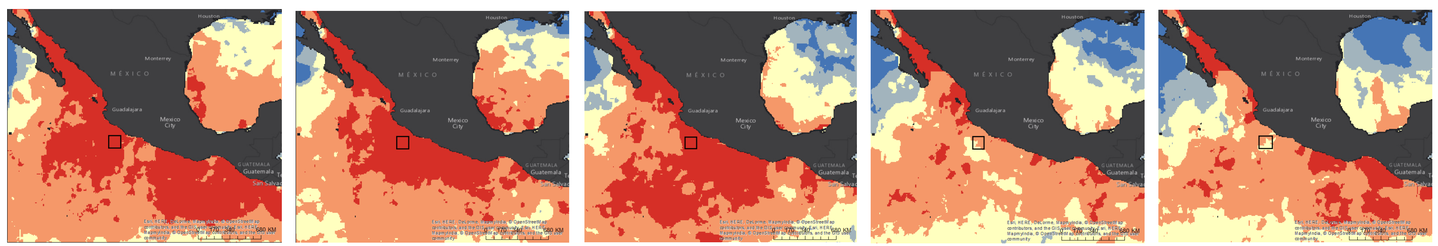
We used R studio to analyze the data. In R studio, we read and plot the data we obtained from the SSMI website. We excluded the data of sea ice, land mass and missing data and converted the unit of SST into degree celsius. And then we defined the extent of our area of study and generated some plots. We generated two kinds of plots, one is the histogram of SST relatives to its frequency, and the other one is the image for the distribution of different SST in the defined extent. We also converted the original files into GeoTiff so that we can further processed them in ArcMap. In ArcMap, we defined five categories of SST and presented them as different colors on our map, and we also added necessary basemap and legend to better demonstrate the map.

Result

Daily SST Data

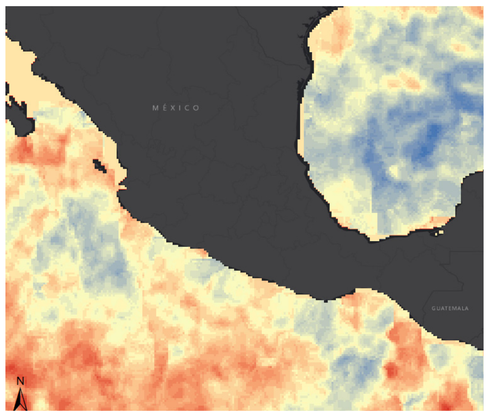


October 20, 2010 | October 20, 2011 | October 20, 2012 | October 20, 2013 | October 20, 2014

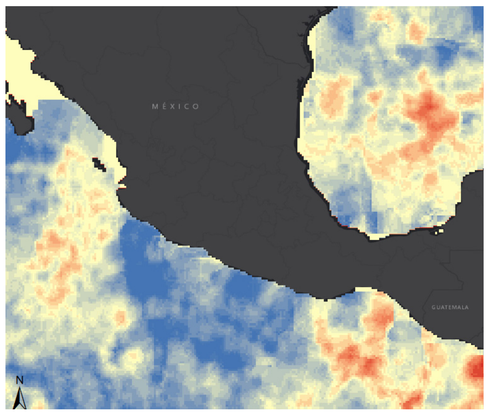


October 6, 2015 | October 13, 2015 | October 20, 2015 | October 27, 2015 | November 3, 2015

Change in SST from Oct 13 to Oct 20, 2015

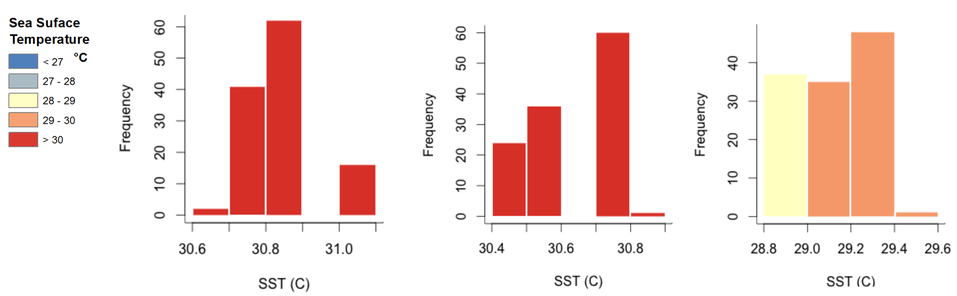


Change in SST from Oct 20 to Oct 27, 2015



Images from October 6 to November 3, 2015

The images above show the SST 1) two weeks before the event, 2) one week before the event, 3) first day of Hurricane Patricia, 4) one week after the event and 5) two weeks after the event. From the images we can see that there was an increase in SST before the hurricane occurred, and the total area of SST that was greater than 30°C also increased. The SST was at around 28.8°C two weeks before the event and it increased to around 30.8°C on the day of the hurricane formation. On October 24, 2015, the hurricane started to dissipate and we can see a great drop in SST from the images above. One week after the event, the SST was at approximately 29.4°C and further dropped to 28.8°C after two weeks. The SST dropped approximately 2°C after the dissipation of the hurricane. Hurricane Patricia was formed on October 20, 2015 which was a Category 5 major hurricane (SSHWS/NWS). From the images of 2015 above we can see that there was an exceptionally high SST in that area on that day at around 30.8°C, much higher than the SST in 2013. In addition, we can see that the SST rapidly increased prior to the formation of the storm and rapidly decreased after it dissipated.



October 13, 2015 | October 20, 2015 | October 27, 2015

Images on October 20 from 2010 to 2014

The images above show the SST on October 20th from the years 2010 through 2014. From year 2010 to 2012 and year 2014, the SST of the area were stable at around 28°C-29°C, which are relatively low compared with 2013 and 2015. On October 20, 2013, Hurricane Raymond was formed in our area of study which was a Category 3 major hurricane (SSHWS/NWS). It briefly affected the southwestern coast of Mexico before turning back out to the sea. From the images of 2013 above we can see that there was a relatively higher SST on that day, which was at around 30°C and could be explained by the formation of Hurricane Raymond.

Reference

[1] Sea Surface Temperature. (n.d.). Retrieved December 5, 2015, from Hurricane Science: http://www.hurricanescience.org/science/basic/sst/
[2] Sea Surface Temperature. (n.d.). Retrieved December 5, 2015, from Remote Sensing Systems: http://www.remss.com/measurements/sea-surface-temperature
[3] Tropical Cyclone Advisory Forecast. Retrieved December 5, 2015, from Oceanic and Atmospheric Administration: http://www.nhc.noaa.gov/gis/archive_forecast.php

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