

Heat Extremes in Major Metropolitan Areas of Texas

Atmospheric Sciences perspective

Rhiannon McDermid, Madison Gordon, Nadia Partida, Chris Ruiz, Evan Laszewski & Yangyang Xu
(Atmospheric Sciences, College of Geosciences)

Introduction

Based on data analyzed from death certificates by the CDC, 8,081 deaths from extreme heat exposure were recorded in the United States from 1999-2010. Within these years, from 2003-2008, Harris County, Texas had the second highest number of heat-related deaths in Texas, with a total of 41 deaths, according to the Texas Department of State Health Services. For a highly developed urban area with substantial infrastructure, the number of deaths recorded in this time period is alarming. Our research aims to highlight communities more vulnerable to extreme heat and rising temperatures within the highly populated Houston metro area. This project is a multidisciplinary research project, involving students with Meteorology, GIS, Computer Science and Public Health backgrounds. The meteorological component of this research ([this poster](#)) aims to highlight areas of Harris County that are the “hottest” using different indices of heat analysis.

Methodology

When analyzing meteorological data we used several different indices of heat.

- Humidex Index- developed in Canada, uses temperature in Celsius and dew point in Kelvin to give a number of perceived heat.
- Heat Index- developed in the United States, uses temperature in Fahrenheit and relative humidity to calculate a “feels-like” temperature.

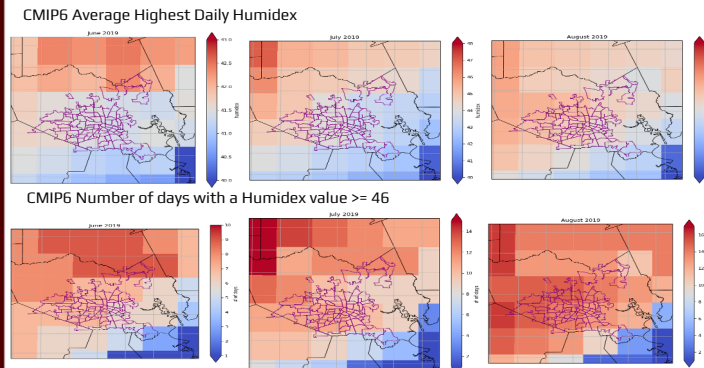
We then used several different sources of data, including observed/reanalysis and climate modeling, to give a wide overview of heat within Harris County during the summer months.

- CMIP6 model output (2015-2020) was used in calculating [the Humidex](#).
 - Temperature was modeled using RCM8.5 assumptions.
 - Highest daily temperature was averaged over each month.
 - Assumption made that dewpoint would not vary much over the area, and used one constant point in order to solve resolution errors.

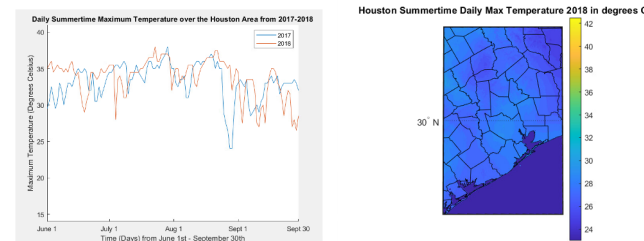
NARR (North America Regional Reanalysis) & ERA5 (a global reanalysis) data was used in calculating [the Heat Index](#).

- ERA5 data is averaged at 1000 hPa over each month using hourly data at times 0Z, 6Z, 12Z & 18Z each day.
 - ☑ Analyzed for 2009, 2014 & 2019.
- NARR data was averaged at 1000 hPa over each month using average daily temperature and relative humidity.
 - ☑ Analyzed for June-September 2019.
- Temporal analysis was conducted June-September 2019 to compare the two indices and evaluate the modeled CMIP6 data.

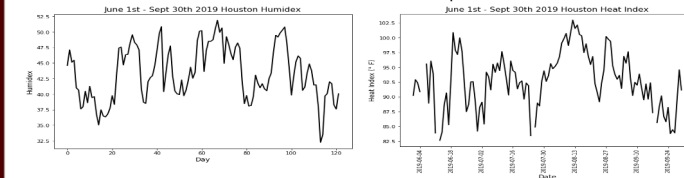
Results



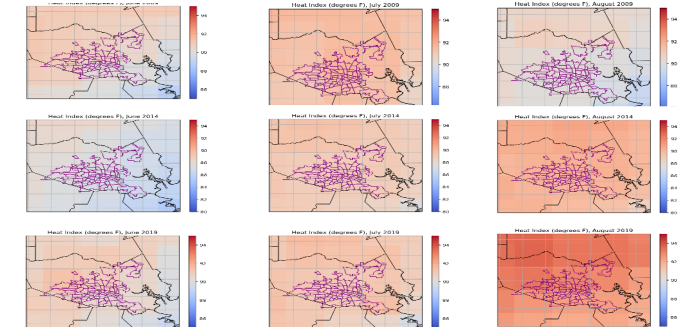
Daymet 1-km Summertime Max Temperature June 1st-Sept 30th 2017-2018



Houston Humidex (CMIP6) and Heat Index (NARR), June- September 2019



ERA5 Average Monthly Heat Index



Conclusions & Future Work

Conclusions

- The Humidex shows that throughout the summer, the Houston Metro area consistently reaches values that are associated with “great discomfort”.
- The Heat Index values across the Houston Metro area were all above 80 degrees F, providing potentially dangerous conditions continuously.
- Heat Index showed an increase of values from 2009- 2019.
- The comparison between modeled Humidex and observed Heat Index showed relatively similar trends throughout June- September 2019.
- Coastal communities tend to experience less heat than urban and rural communities.
- Across all types of modeling we can see that the most extreme heat days are more likely to be in July and August, as June is consistently cooler.
- Just knowing the warmest parts of the city is not enough to determine which communities are most in danger on hot days. Determining other factors such as: whether the area is a residential or commercial area; the age of the people living there; the predominate socioeconomic status of the population; and the general health trends of the area, are vital to accurately perceiving how susceptible people are to extreme heat.

Future Work

- Use ArcGIS to map socioeconomic and health data as well as areas of greenspace and urban sprawl.
- Combine data to create an index that highlights vulnerable communities.
- The ultimate goal is to help inform local authorities and communities so they can be more prepared and knowledgeable about specific concerns they face in their community due to extreme heat.

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Public Health perspective

Minaal Farrukh, Kendahl Hejl, Angelina Choi, Sophia Nguyen (SPH) & Yangyang Xu (Geosciences)

Introduction

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For a highly developed urban area with substantial infrastructure, the number of deaths recorded in this time period is alarming. Our research aims to highlight communities more vulnerable to extreme heat and rising temperatures within the highly populated Houston metro area. This project is a multidisciplinary research project, involving students with Meteorology, GIS, Computer Science and Public Health backgrounds.

The public health component of this research ([this poster](#)) aims to prove the effect of heat on health in Houston and how some demographics are more predisposed to heat illness than others.

Methodology

- Our team used several public sources to gather data for heat related illness and death in the Houston metropolitan area.
- To better understand the frequency of heat related illness and death in Houston, we used local government data from the Houston Health Department and Texas Department of Health Services.
- Working with GIS students, we mapped heat related illness in Houston. Using this map we searched for other public databases to understand if demographics or preexisting conditions plays a role in who is more predisposed to heat illness.
- By using what public information was available, we mapped by location: coronary heart disease, income levels, and concentration of a minority population. We used these maps to determine if there was any relationship between heat illness and demographics.

References

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Results

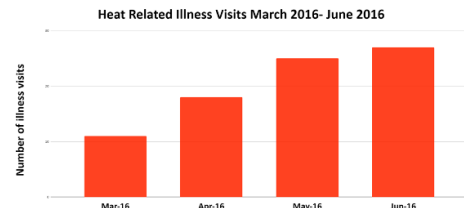


Figure 1: This figure is a bar graph depicting heat related illness visits in Houston in 2016 as the temperatures rose as Houston approached summer.

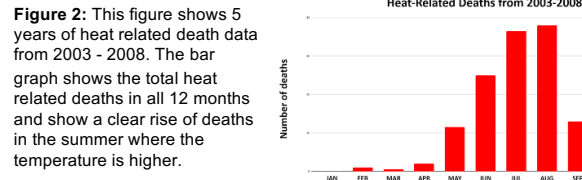


Figure 2: This figure shows 5 years of heat related death data from 2003 - 2008. The bar graph shows the total heat related deaths in all 12 months and show a clear rise of deaths in the summer where the temperature is higher.

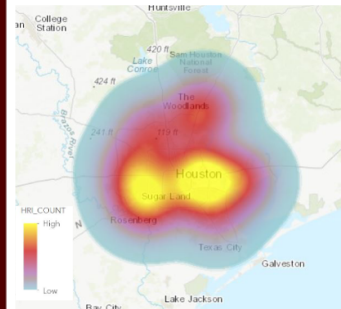


Figure 3: This figure shows a map of Heat related illness from March through August in 2016 by Zip Code. Yellow depicts more illness.

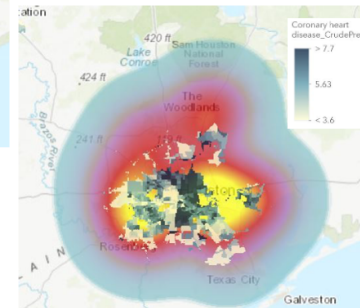


Figure 4: This figure overlays Figure 3's with Coronary heart disease rates in the the Houston. A darker blue color means there is a higher rate of Coronary heart disease in that area.

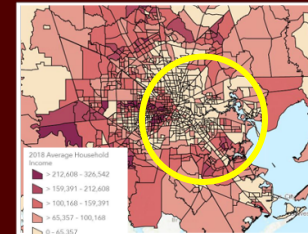
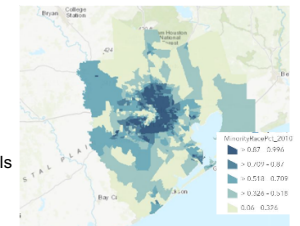


Figure 5: This figure shows a map of income levels in Houston. The lightest color indicates a lower income and we can see a concentration of lower income levels towards center right of the map.

Figure 6: This figure shows a map of the concentration of the minority population in Houston. The darker blue indicates a higher concentration.



Conclusions & Future Work

This research was conducted to better understand how high temperatures can affect people's health.

- Figure 1 shows a clear increase in heat related illness visits to health care providers as Houston approaches their summer months and Figure 2 reaffirms the idea that heat related illness increases in higher temperatures as 5 years of cumulative data shows a clear rise in heat deaths during the summer.
- While there is a clear increase of heat related illness in higher temperatures, we wanted to understand if there are certain population groups that are at higher risk for heat related illness and death.
- Figure 3 shows that our research found that heat related illness was concentrated in central Houston where the yellow area on the map shows
- Figure 4 shows a higher concentration of coronary heart disease rates towards central Houston and over the higher concentration of heat related illness. This shows the two could possibly be related.
- Figure 5 shows there is a higher concentration of a population with lower income in central Houston in the same area where there is a higher rate of heat related illness indicating a possible relation.
- Figure 6 shows where the minority population lies in Houston and this population is also concentrated in central Houston showing there may be a relationship between population type and heat related illness.
- When looking at Figure 3, 5, and 6 altogether, they show there may be a relationship between socioeconomic status and heat related illness.
- When looking at Figure 4, we can see the population with a higher rate of coronary heart disease lay in the same location as where there is a higher rate of heat related illness indicating this preexisting condition may be related to a high rate of heat illness.
- Our team was able to conclude that there is a relationship between higher temperature and illness and death. This is an important finding as the rise of climate change can mean higher temperatures causing more illness and death.
- We also concluded that there may be some relationship between pre-existing conditions, socioeconomic status, and heat illness.
- In the future, we need more comprehensive data from our governments on the rate of heat illness in our cities, an increased focus from health providers to collect this data so we can better understand if there is a relationship between rates of heat illness, climate change, and demographics.