

# “Temperature Changes in San Antonio”

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## Background

Global warming, the increase in temperature, a well known component of climate change. There are many reasons for the change in temperature. Reasons for the change includes natural variability of Earth's climate, volcanic eruptions, and human emissions of greenhouse gases.

On the global scale the temperatures have increased by 1.3 to 1.6°F per 100 yrs for the period 1900 – 2017. Since 1975 the rate of temperature increase to 2.7 to 3.2 F per 100 years. (Sanchez-Lugo, et al., 2018). The greatest temperature change has been observed in the polar regions and smaller changes near the equator. (Dunn, et al., 2018)

On the smaller scale (mesoscale) temperature changes at specific locations (cities) varies more.

This study looked at the temperature changes in San Antonio during the last 134 years. This study looked at two primary areas which were the urban heat island affect & trends compared to global warming.

## Experimental Method

- Reviewed 134 years of annual temperature data from San Antonio International Airport -- Collected annual data from Blanco, Lulling, and Hondo
- Retrieved historical population data for San Antonio, Hondo, Blanco, and Lulling from U.S Census Bureau
- Used Excel software to calculate annual means and developed graphs
- Analyzed data for patterns & trends. Compared results to other climatologically studies.

## Research Question #1

**Question:** Was there any trends in long term temperature in San Antonio?  
- Compare San Antonio trends to global temperature change

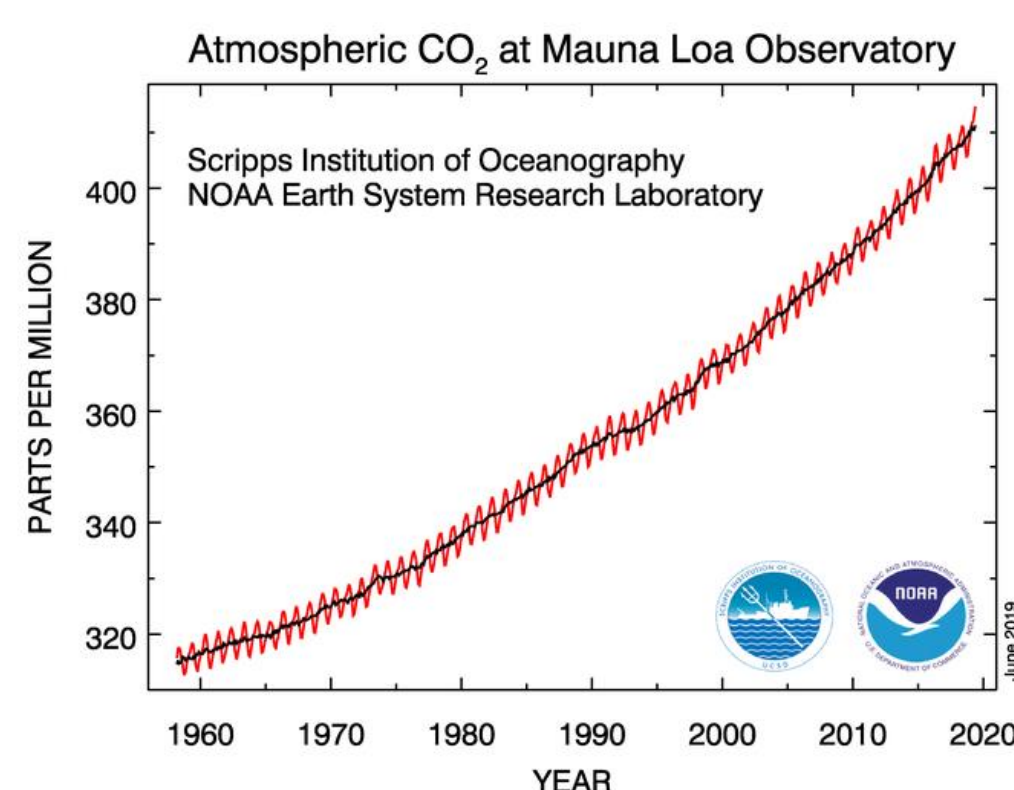
### Assumptions & Definitions:

1. Mean global temperature is the land temperature around the world for period 1900-1999.
2. Carbon Dioxide (CO<sub>2</sub>) is a greenhouse gas and also absorbs heat.
3. An increase in CO<sub>2</sub> level should increase global temperature.

### Results:

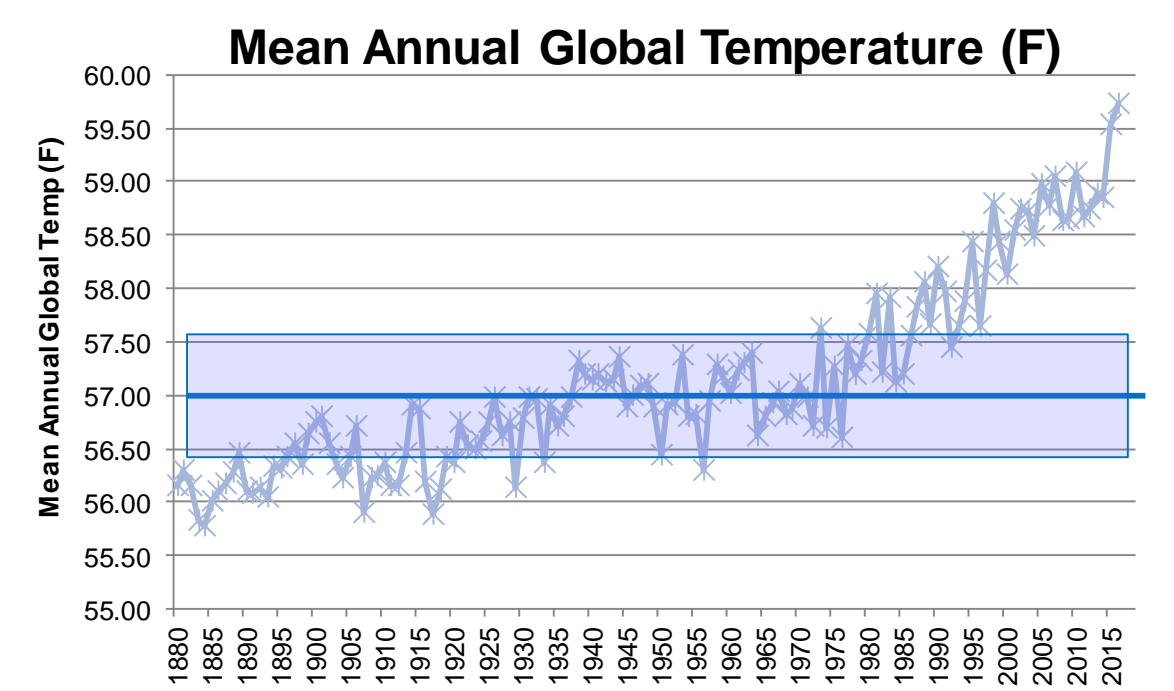
1. CO<sub>2</sub> levels measured in Hawaii rose from 316 ppm in 1959 to 409 ppm in 2018 (Graph #1).
2. Mean global temperatures have been rising since the 1980's (Graph #2)  
- Rate of change in annual global temperatures has increased since 2005
3. San Antonio temperature trend for period 2005 to 2018 showed significant warming (Graph #3)  
-Annual temperatures were one standard deviation above the 134yr mean (69.2 F).
4. Other changes during the past 134yrs were within one standard deviation.  
-The standard deviation is ± 0.7 F

**Graph #1: Annual CO<sub>2</sub> levels**



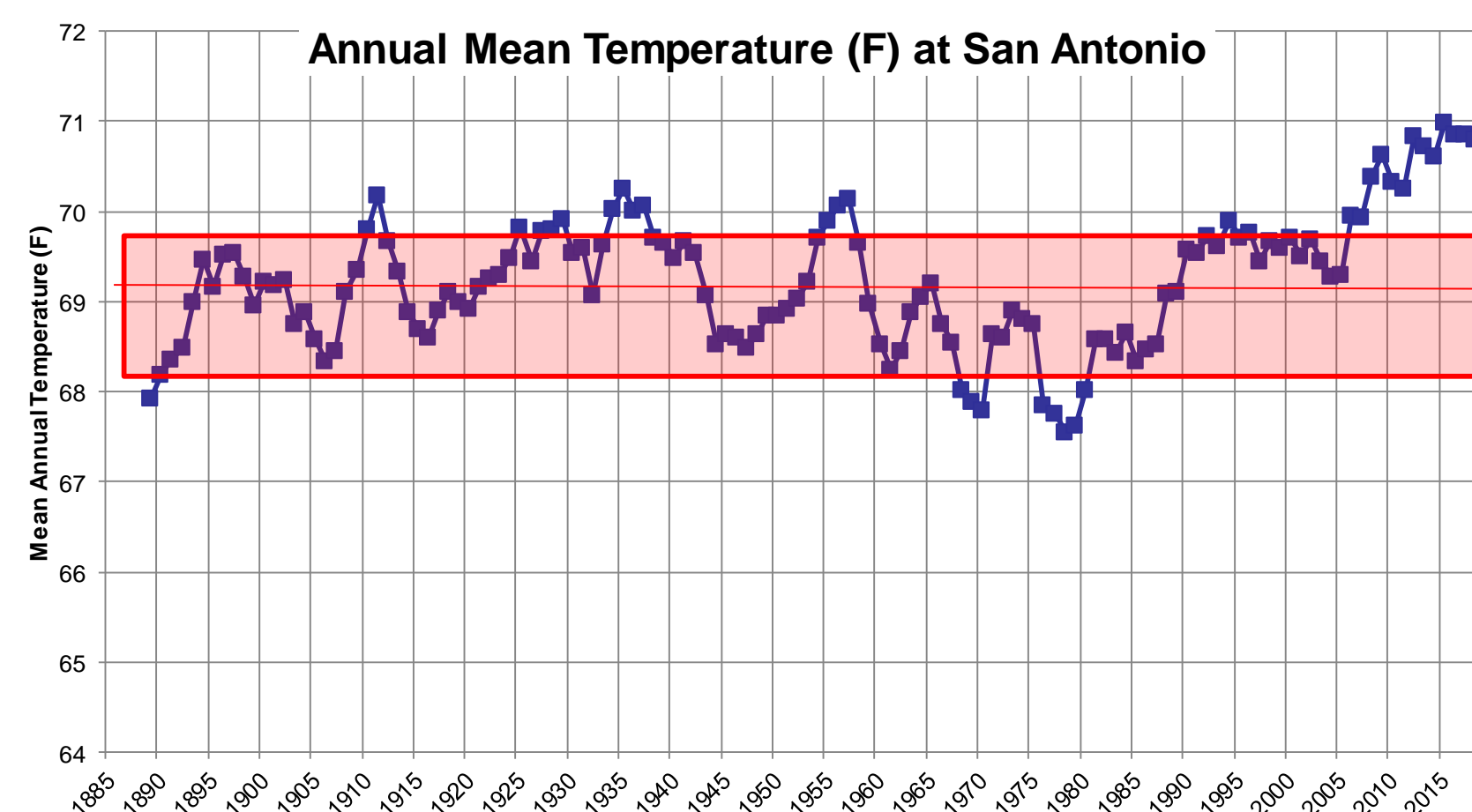
**Graph #2: Mean Annual Global Temperature (F)**

Blue shaded area indicates 1 standard deviation above 7 below 1900-1999 mean Global Temp



**Graph #3: Annual Temperature at San Antonio, Texas**

{Red shaded area indicates 1 standard deviation above & below the 1900-1999 mean Temperature (F)}



## Research Question #2

**Question #2:** Is there a urban heat island affect in San Antonio?

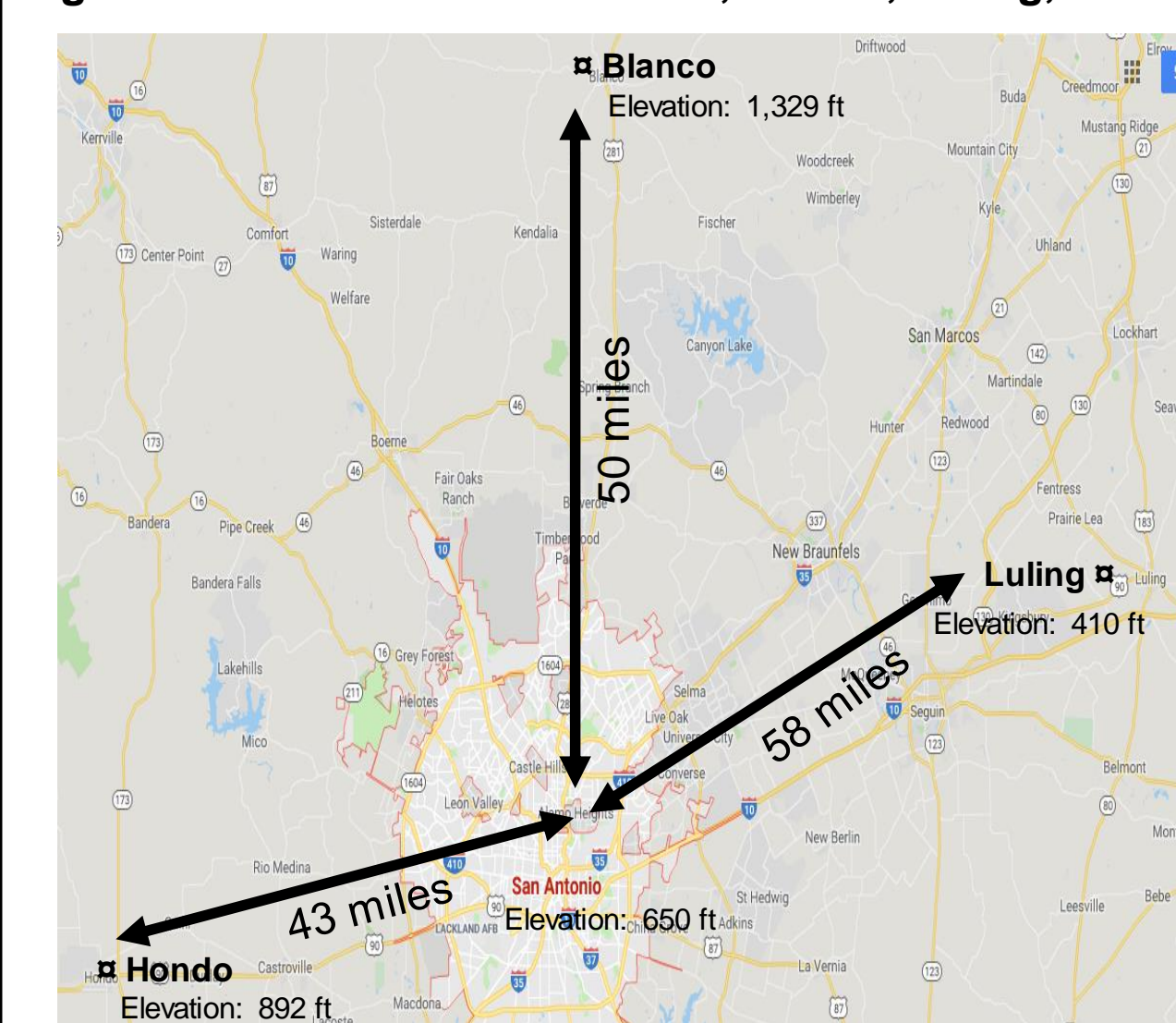
### Assumptions & Definitions:

1. Urban areas contain more concrete and asphalt which absorbs more solar energy, increasing temperatures than rural areas.
2. Blanco, Lulling, Hondo were chosen because they're rural and is 60 miles away from San Antonio.

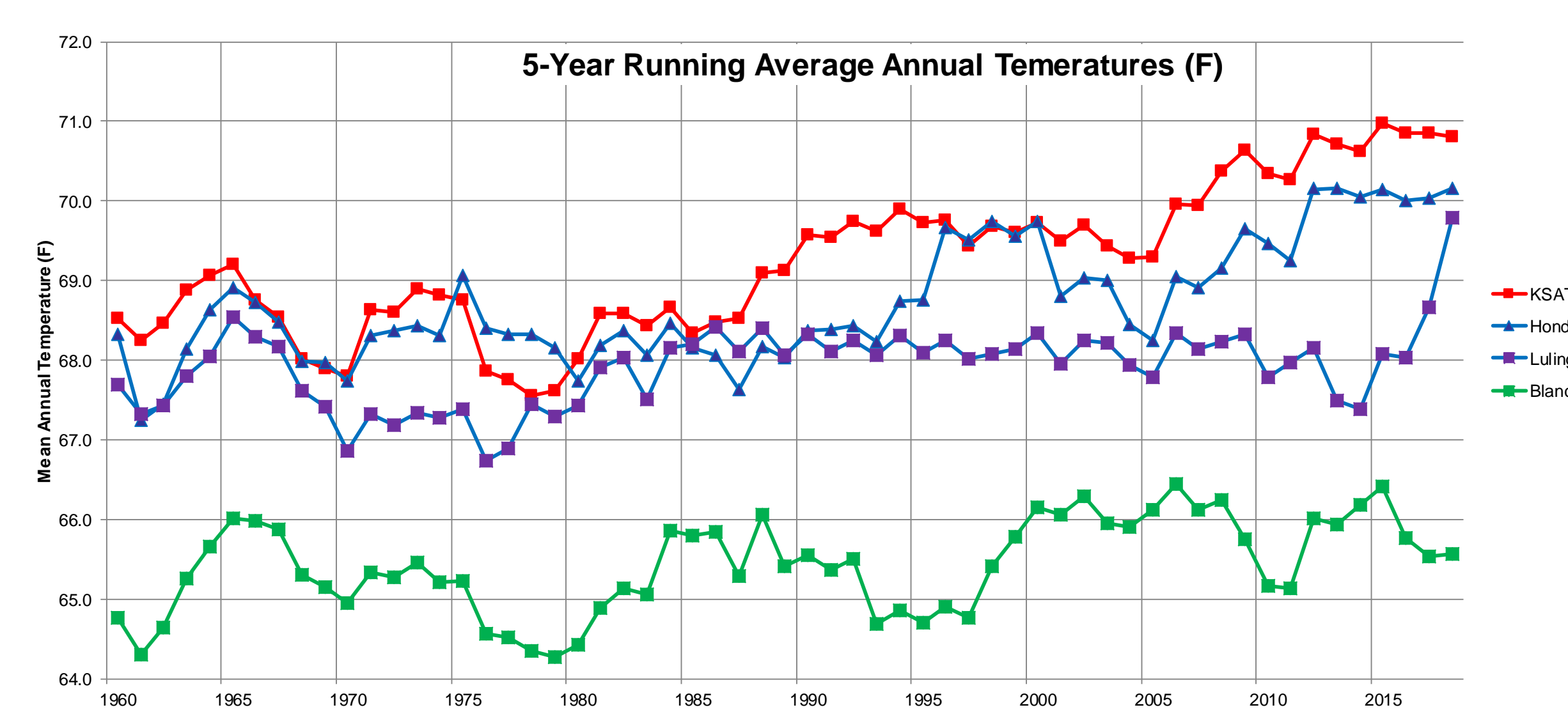
### Results:

1. Graph #4 shows San Antonio mean annual temperatures were 0.5 F warmer than Hondo, 0.8 F warmer than Luling, and 3.8 F warmer than Blanco.  
- Since San Antonio is warmer than the surrounding rural locations there is a urban heat island affect
2. In the past 11yrs the urban heat island effect has increased  
- Temperature differences between San Antonio to Luling increased by 2.5 to 3.0 F  
- Temperature difference between San Antonio to Blanco increased by 4.5 to 5.0 F
3. Blanco's average annual temperature is lower due to elevation  
- Difference in elevation between San Antonio and Blanco is 679 ft ( standard temperature drop is 2.5 F per 500 ft increase in elevation )

**Figure #1 location at San Antonio, Hondo, Luling, & Blanco**



**Graph #4 5-Year Running Average Mean Annual Temperatures (F) between 1960-2018 at San Antonio, Hondo, Luling, & Blanco**



## Research Question #3

**Question #3:** Do temperatures change with increasing population?

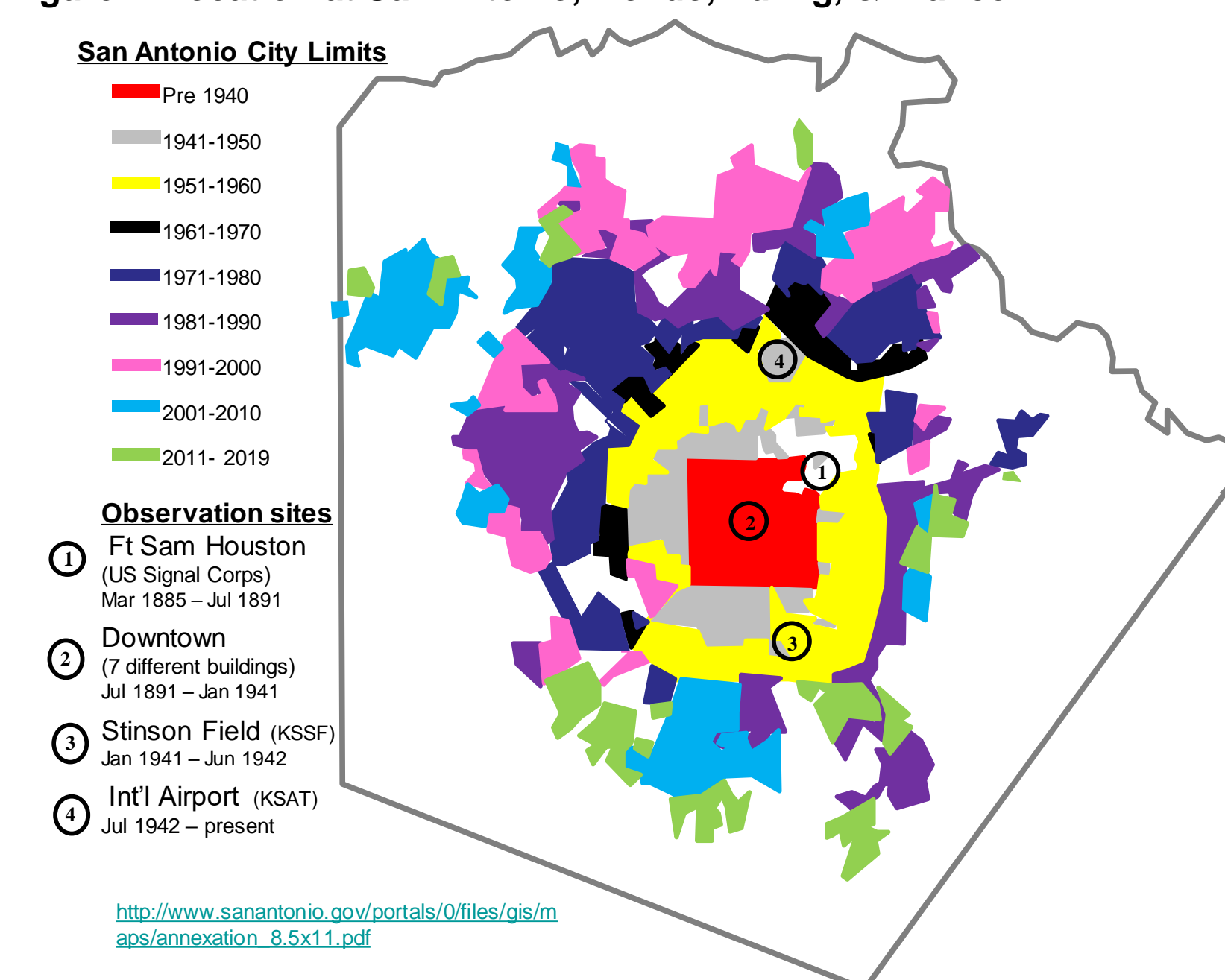
### Assumptions & Definitions:

1. Census data are collected every 10yrs
2. Population data are only for San Antonio, does not include the suburbs or metro areas.
3. Assumes the area within the city's boundaries are developed .

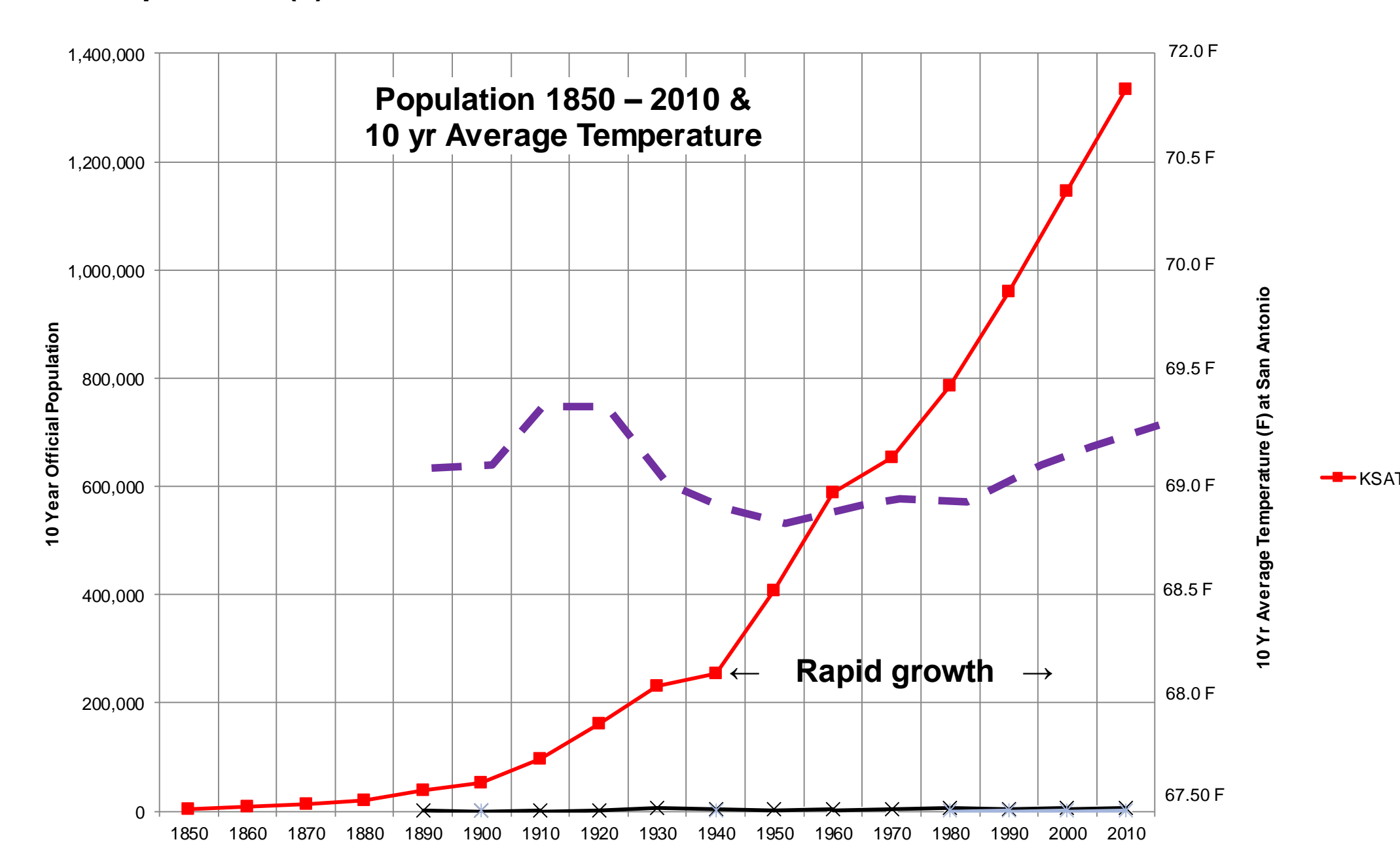
### Results:

1. After 1940 San Antonio grew rapidly in both city size and population  
- Also 10yrs average temperature increased by 0.5 F
2. The temperature increased between 1900 to 1920 due to moderate to severe droughts in south Texas.  
- 5 of the driest years ever in san Antonio occurred during this period, resulted in hot conditions.  
- 31 all time high temperatures were recorded in the last 20 years.

**Figure #2 location at San Antonio, Hondo, Luling, & Blanco**



**Graph #5 Population Growth for San Antonio, Hondo, Luling, and Blanco and 10 Year Average Temperature (F) at San Antonio**



## Conclusions

1. Since 2005 San Antonio annual temperature has increased outside the one standard deviation from the long term average (years 1900-1999).  
- Trend in San Antonio temperatures is similar to the change seen in the global temperature trend.
2. There is a urban heat island (UHI) affect in San Antonio.  
- The UHI is greater between San Antonio and Blanco due to the difference in elevation.  
- The UHI affect has increased during the past 11 years.
3. Since the 1940's the temperature has increased with the growth in San Antonio's size and population.  
- This result is similar to the pattern shown in Oke's 1973 paper

## References

**Population Data:** U.S. Census Bureau (<https://exasalmanac.com/sites/default/files/images/CityPopHist%20web.pdf>)  
**Temperature Data:** National Weather Service: Austin - San Antonio ([www.ncdc.noaa.gov/IPS/kd/led.html](http://www.ncdc.noaa.gov/IPS/kd/led.html))  
**Distances:** Google Maps  
**CO<sub>2</sub> levels:** NOAA Earth System Research Lab (<https://www.esrl.noaa.gov/gmd/ccgg/trends/>)  
**San Antonio Maps & Pictures:**  
**References:**  
Dunn, R. J.H., D.M. Stanitski, N. Gobron, & K. M. Willet, 2018: Global Climate, {in "State of the Climate in 2017"}, *Bulletin of the American Meteorological Society*, 99 (8), S11-13, 2018  
Chow, Winston, Dean Brennan, & Anthony Brazel, "Urban Heat Island Research in Phoenix, Arizona, *Bulletin of the American Meteorological Society*, Vol. 93 No 4, Apr 2012  
Oke, T. R., *City Size and the Urban Heat Island*, Atmospheric Environment Pergamon Press Vol. 7, pp. 769-77, 1973  
Sanchez-Lugo, A., C. Morice, P. Berrisford, & A. Arguez, 2018: Global Surface Temperatures, {in "State of the Climate in 2017"}, *Bulletin of the American Meteorological Society*, 99 (8), S11-13, 2018

## Acknowledgements

